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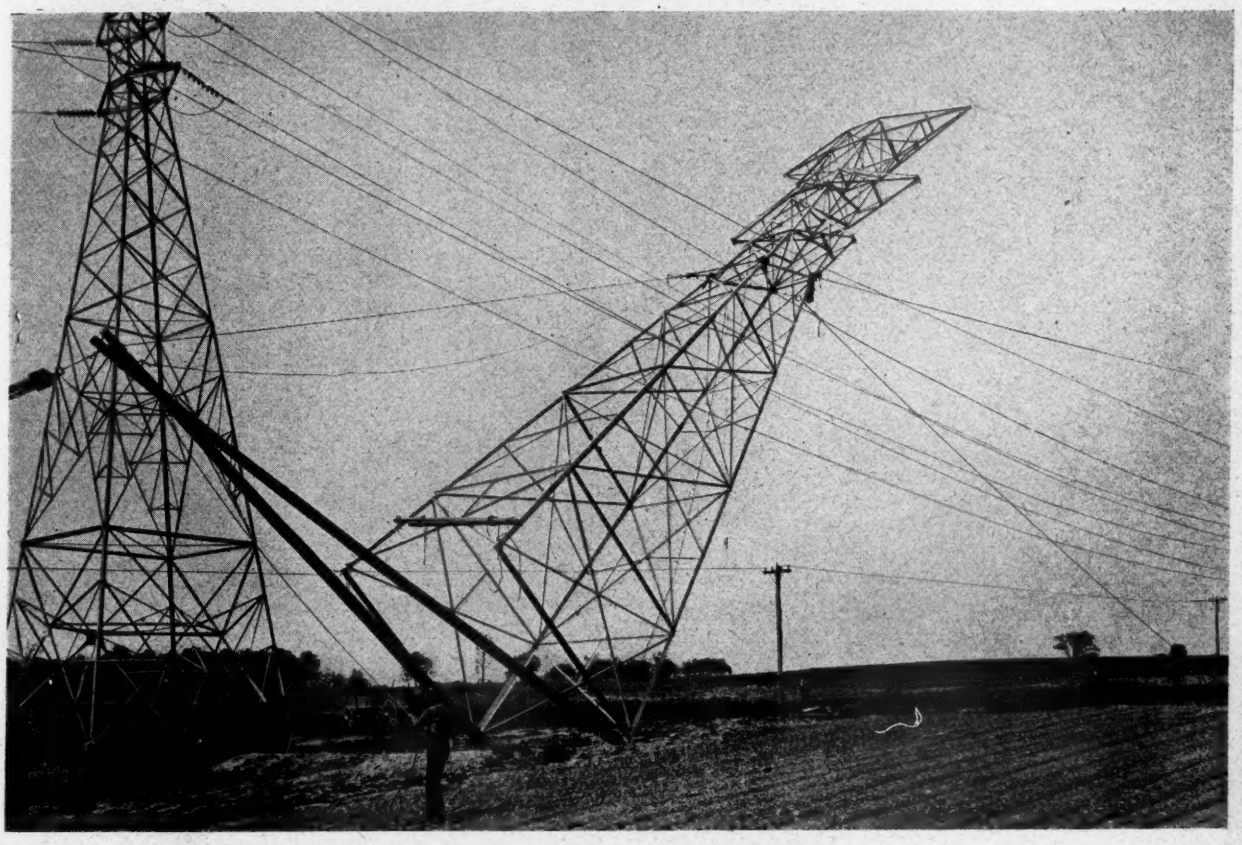


Method of Erecting Towers From Prone Position.

Steel Transmission Line Towers

Review of the Latest Engineering Practice in Connection with Loading and Wind Pressure on Transmission Towers and Lines

By E. F. GEMMILL

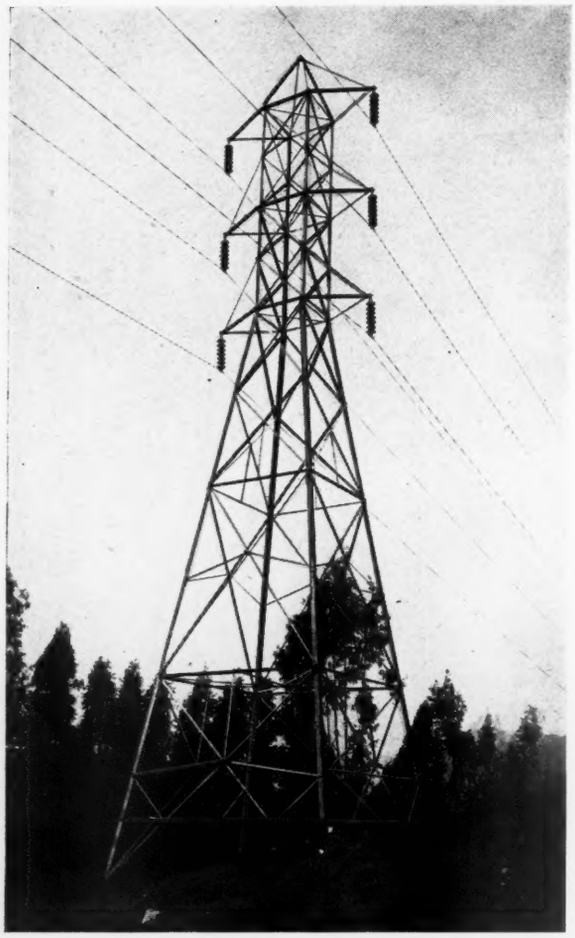
Chief Engineer, Transmission Tower Department, Blaw-Knox Co., Pittsburgh.

It is only within the last 25 or 30 years that it has been considered advisable to carry overhead electric power transmission lines on anything else but wood poles. But with the ever-increasing tendency to concentrate powerhouse units, and consequently to make fewer and larger installations, located farther apart, it has become necessary to transmit electrical energy over greater distances. This, in turn, has made it advisable to set a higher limit for the voltage at which electrical energy will be conveyed from one point to another, in order to reduce to the lowest possible minimum the loss in transmission. The use of these higher voltages has, of course, brought in its train the necessity of making more careful provisions for supporting the conductors by means of which the electrical energy is transmitted from one point to another. Naturally, the first change made in the general scheme in vogue was to place the conductors farther apart, which necessitated the use of better crossarms for supporting them. At the same time it was also imperative that, with increased voltage, more clearance be allowed between the ground and the lowest conductor wires under the worst possible conditions of operation. This could best be accomplished by making the supporting structures higher.

So long as the wires were kept only a short distance above the ground, wood poles made an ideal support for them under ordinary conditions; but when higher supports had to be considered, transmission line engineers began looking about for other supporting structures

which would lend themselves more readily to all the varying conditions of service. The steel structure was immediately suggested as the proper support to take the place of the wood poles, and many arguments were advanced in its favor.

But these supports when built of steel were more expensive than wood poles and in order



Rigid Steel Tower for Carrying a Double-Circuit 110,000-Volt Line.

to keep the total cost of the line equipment down to a minimum, and to make such an installation compare favorably with a similar line using the wood poles, it became necessary to space the steel supports farther apart, so as to use fewer supports to cover the same length of line.

The steel support, however, had come to stay, and the whole problem resolved itself into a matter of making a careful investigation and study of each installation, in order that there might be used that system which apparently worked out the best in each particular case. From these several projects there have been evolved the different types of structures in use today for transmission line work. They may be roughly divided into three general types, namely: poles, flexible frames and rigid towers.

Steel Poles.

All supports that are relatively small at the base or ground line are generally classified as poles. In plan at both ground line and near the top they are made in several different shapes. They may be round, square, rectangular, triangular, or of almost any other section. As a rule, their general outline is continued below the ground line to the extreme bottom of the anchorage.

They are usually intended merely to take care of the vertical loads combined with horizontal loads across or at right angles to the direction of the line. They may have greater strength transverse to the line than in the direction of the line, but they are often made of the same strength in each direction. Poles are rarely designed to take care of any load in the direction of the line when combined with the specified load across the line. They must be spaced closer together than the heavier structures, but can be spaced much farther apart than wood poles. A very common spacing for steel poles is about 300 feet apart.

Flexible Steel Frames.

Flexible frames are heavier structures than the poles, and are intended to take care of longer spans. Like the poles, their chief function is to take care primarily of transverse loads with a small margin of safety so that under unusual conditions of service they can also provide a little resistance in the direction of the line, i. e., in a measure distribute a load coming in this direction over a number of supporting structures, and transfer such a load to the still heavier structures placed at regular intervals in the line. Or the flexible frames may transfer all loads coming on them in the direction of the line to a point where they will be resisted by a frame of similar construction and strength, but which is made secure against the action of such loads by being anchored in this direction with guy lines.

Flexible frames are almost always rectangular in plan. Generally the parallel faces in both directions are made smaller as the top is approached, but often the two faces parallel to the direction of the line will be of the same width from the bottom to the top. But the two faces transverse to the line are almost always tapered from the ground line up, becoming smaller toward the top. The two faces parallel to the line are generally extended below the ground line to form the anchorages.

Rigid Steel Towers.

Rigid towers are the largest and heaviest structures made for transmission line supports, and, as would be implied by the designation given them, they are intended to have strength to carry loads coming upon them either in the direction of the line or at right angles to this direction. They are usually designed to take a combination of loads in both directions. These towers are built in triangular, rectangular and square types, depending upon the particular conditions under which the structure is to be used. When a plan of the tower at the ground line is square in outline each side of the square will be much larger than in the case of either poles or flexible frames. The width of one side of a rigid tower, measured at the ground line, will vary somewhere between about one-seventh and one-third of the total height of the structure. This dimension is usually determined by the construction which will give the most economical design, especially when there are a large number of the towers required;

but it often happens that the outline of one or more of the structures will be determined by local conditions which are entirely foreign to the matter of economy of design. Then, too, the conditions of loading may be such as to make a special outline the most economical design.

Loading of Towers.

There are three kinds of loads which come upon transmission line supports: (1) The dead load of the wires together with any coating on them; also the dead weight of the structure itself. (2) Wind loads on the wires and the structure transverse to the direction of the line. (3) Pulls in the direction of the line caused by the dead load and the wind load on the wires.

The dead load on the wires consists of the weight of the wire itself, plus the weight of any insulating covering, plus the weight of any coating of snow or sleet. In most installations the conductors are not covered with insulating material, and hence at the higher temperatures the dead load will be the weight of the wire only. At the lower temperatures the wires may be coated with a layer of ice, varying up to a thickness of 1 in. or more around the wire. In some instances ice has been known to accumulate on conductor wires until the thickness of the layer would be as much as 1¼ in. all around the wire. But such instances are rare, especially on wires carrying high voltages, because there is generally enough heat in these wires to interfere with the accumulation of much ice on them. But the heaviest coating of ice alone does not often produce the worst conditions of loading for the conductor and the supporting structure.

The worst conditions of loading is that resulting from the strongest wind blowing against a conductor covered with that coating which offers the greatest area of exposed surface to the direction of the wind under all the several conditions obtaining. This will almost always be true when the wind is blowing horizontally and at right angles to the direction of the line. In this case the total horizontal load on the supporting structure from the wires is the combination of the wind load against the wires and the unbalanced pull in the direction of the line, which is produced by the resultant of the horizontal wind load and the weight of the wire itself and any covering. But it does not follow that this condition will always give the maximum load on the structure. In mountainous districts it may happen that a transmission line will be subjected to a gust of wind blowing almost vertically downward, in which case this pressure, being added directly to the weight of the wire and the ice load, may lead to much more serious results than a wind of equal or even greater intensity blowing horizontally across the line. It may happen in some districts where large sleet deposits are to be encountered that the vertical load from the dead weight of the wire and its coating of ice will be so great as to produce in the wire a tension large enough to break the wire, even without any added load from the wind. This is especially true if the wire is strung with a very small sag.

Since the design of the transmission line supports is determined very largely by the loads which it is assumed will come upon them, and since the load resulting from the pull in the direction of the line is very often the dominating factor; and, further, since this load is a function of the resultant load on the wire produced by the wind load and the dead load, it naturally follows that the assumptions made regarding the amount of this resultant loading are a matter of prime importance. For this reason some very extensive experimenting has been done to determine the amount of wind pressure against wires, either bare or covered, under extreme conditions of velocity, density of air and temperature. Careful observations have also been made to find out, as near as possible, what is the maximum quantity of ice that will adhere to a wire during and after a heavy storm. It not infrequently happens that the temperature falls and the wind velocity increases immediately after a sleet storm. The falling temperature, of course, tends to make the ice adhere more closely to the wires. On the other hand, a rising wind will tend to remove some of the ice from the wires.

In places where the lower temperatures prevail, the wind velocity rarely gets to be as high as in the warmer districts where sleet cannot form. On the other hand, a moderate wind acting on a wire covered with a coating of ice will oftentimes put much more stress into the wire than a higher wind acting on the bare wire. This means that the conditions of loading are altogether different for different sections of the country. It is now generally assumed that in those districts where sleet formation is to be met, the worst condition of loading on the wire

Rigid Steel Towers for Carrying a Double-Circuit 130,000-Volt Line.

will be obtained when the wires are covered with a layer of ice 1½ ins. thick, the amount of the wind pressure on them, of course, depending upon the wind velocity and the density of the air.

Wind Pressure on Plane Surfaces.

The wind pressure per unit area on a surface may be obtained by the following formula:

$$P = K \frac{v^2 W}{2 g}$$

in which

v = velocity of wind in feet per second;
W = weight of air per unit cube;
g = acceleration of gravity in corresponding units;
K = coefficient for the shape of the surface.

The factor $\frac{v^2 W}{2 g}$ is called the velocity head.

In considering the pressure on any flat surface normal to the direction of the wind, the pressure may be regarded as composed of two parts: (1) front pressure, and (2) back pressure.

The front pressure is greatest at the center of the figure, where its highest value is equal to that due to the velocity head. It decreases toward the edges. The following conclusions are generally regarded as fair and reliable deductions from the results of many experiments made by several investigators to determine the amount and distribution of wind pressures on flat surfaces: (1) The gross front pressure for a circle is about 75% of that due to the velocity head, while for a square it is about 70%, and for a rectangle whose length is very long compared with its width it is somewhere between 83% and 86%. (2) The back pressure is nearly uniform over the whole area except at the edges. (3) This back pressure is dependent on the perimeter of the surface and will vary between negative values of 40% and 100% of the velocity head. (4) The maximum total pressure on an indefinitely long rectangle of measurable width may be taken at 1.83 times the velocity head pressure. For a very small square, the coefficient may be as small as 1.1.

Using the value for W corresponding to a temperature of freezing, or 32 deg. F., and a barometric height of 30 ins., which is 0.08071 lb. per cu. ft., and changing the wind velocity from ft. per sec. to mi. per hr., the formula for normal pressure per sq. ft. on a flat surface of rectangular outline becomes:

$$P = 1.83 \times \frac{0.08071}{2 \times 32.2} \times \frac{5280}{60 \times 60} \times \frac{5280}{60 \times 60} \times V^2$$

or $$P = 0.0049335\ V^2$$

Wind Pressure on Wires.

In the case of cylindrical wires the pressure per square foot of projected area is less than on flat surfaces. The coefficient by which the pressure on flat surfaces must be multiplied to obtain the pressure on the projected surface of a smooth cylinder, varies, according to different authorities, from 0.45 to 0.79. Almost all engineers in this country assume this coefficient to be 0.50, and, on this assumption, our formula becomes

$$P = 0.00246675\ V^2$$

for the pressure per sq. ft. on the projected area of the wire, with any coating it may have on it.

H. W. Buck has given the results of a series of wind pressure experiments made at Niagara on a 950-ft. span of 0.58-in. stranded cable, erected so as to be normal to the usual wind. From the data obtained, the following formula was derived:

$$P = 0.0025\ V^2$$

in which P = Pressure in lbs. per sq. ft. of projected area; V = Wind velocity in mi. per hr.

For solid wire previous experimenters had derived the formula:

$$P = 0.002\ V^2$$

It is to be noted that Mr. Buck's formula gives values for pressures 25% in excess of the other

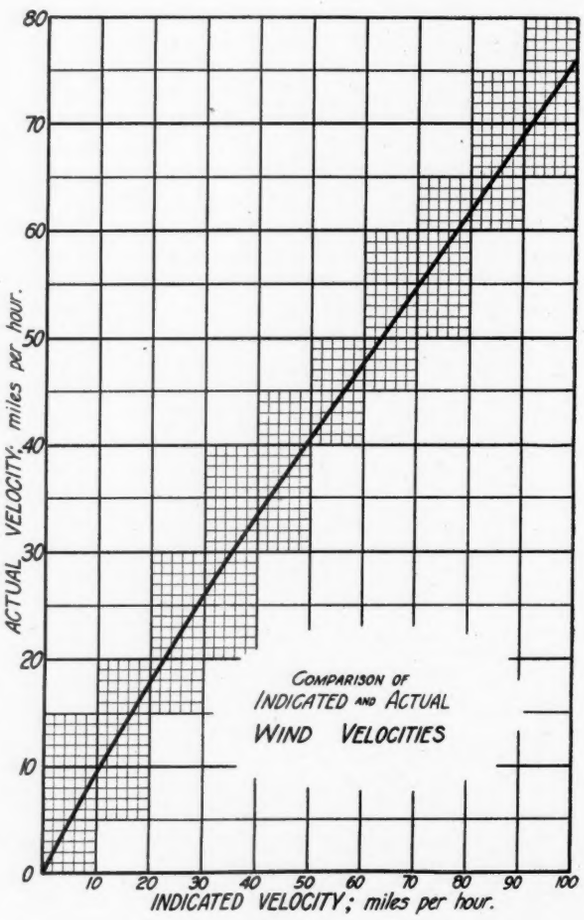


Fig. 1.

formulas, which might be attributed to the fact that for a given diameter a cable made up of several strands presents for wind pressure a different kind of surface than a single wire. If we could be sure that this difference exists then it would be well worth while to take this into consideration when determining the loads for which a tower is to be designed, and to make a careful distinction between towers which are to support solid wires and those which are to carry stranded cables. Almost all engineers are inclined to accept the formula given by Mr. Buck

and to assume it to be correct for both types of conductors. The fact that this formula agrees so closely with the formula arrived at by assuming that the pressure on the projected area of a cylindrical surface is 50% of the pressure on a rectangular flat surface would seem to warrant accepting it as being correct.

Wind Velocity.

In assuming the loadings for which a line of towers are to be designed, the first thing to be determined is the probable wind velocity which will be encountered under the worst conditions. Calculations, of course, should be based on *actual* velocities. This is mentioned because it is necessary to distinguish between indicated and true wind velocities. The indicated velocities are those determined by the United States Weather Bureau. Its observations are made with the cup anemometer and are taken over five-minute intervals. The wind velocities over these short periods of time are calculated on the assumption that the velocity of the cups is one-third of the true velocity of the wind, for both great and small velocities alike. As the result of considerable investigation, it has been found that this assumption is not correct, but that the indicated velocity must be corrected by a logarithmic factor, to convert it into the true velocity. The actual wind velocities corresponding to definite indicated velocities, as given by the United States weather reports, are as follows:

Indicated	*Actual*	*Indicated*	*Actual*
10	9.6	60	48.0
20	17.8	70	55.2
30	25.7	80	62.2
40	33.3	90	69.2
50	40.8	100	76.2

It is generally conceded that wind pressure increases with the height above the ground, and that it is more severe in exposed positions and where the line runs through wide stretches of open country than it is in places which are more or less protected by their surroundings.

If we accept the theory advanced by some to the effect that the ground surface offers a resistance to the wind, which materially lessens its force, then we must conclude that after a certain altitude has been reached the effect of this resistance becomes negligible, and that beyond that altitude the rate of increase in wind pressure must be small. This is especially true because the density of the air is less in the higher altitudes which tends to counteract some of the effect of increases in velocity. But experimental data bearing on this matter are very limited, so that the rate of increase in wind pressures for higher elevations above the ground must in each case be determined by the judgment of the engineer who is designing the installation.

The curve shown in Fig. 1 gives the relationship between indicated velocity and actual velocity, and the curve shown in Fig. 2 gives the pressure in pounds per sq. ft. of projected area of wire, corresponding to actual velocities in mi. per hr. By placing above the curve shown in Fig. 2 a similar curve corresponding to the indicated velocities, a direct comparison between the two different velocities may be made in terms of pressure. This is shown in Fig. 3.

For the general run of transmission line work no special allowance is made for the pressures on towers at different elevations; but pressures are used which are considered to be fair average values for the particular location of the line and for towers of heights which usually prevail. But, of course, there is a distinction made between requirements for a low pole line and for a line on high steel towers. This applies both to the wind pressures which it is assumed will be encountered and also to the fact of safety expected in the construction throughout.

Standard Practice for Wind and Ice Loads.

The Committee on Overhead Line Construction of the National Electric Light Association assumes an ice coating ½ in. thick all around the wire for all sizes of conductors and maximum wind velocities of 50 to 60 mi. per hr. as being an average maximum condition of loading. This committee states that 62 mi. per hr. is a velocity not likely to be exceeded during the cold months.

Three classes of loading are considered by the

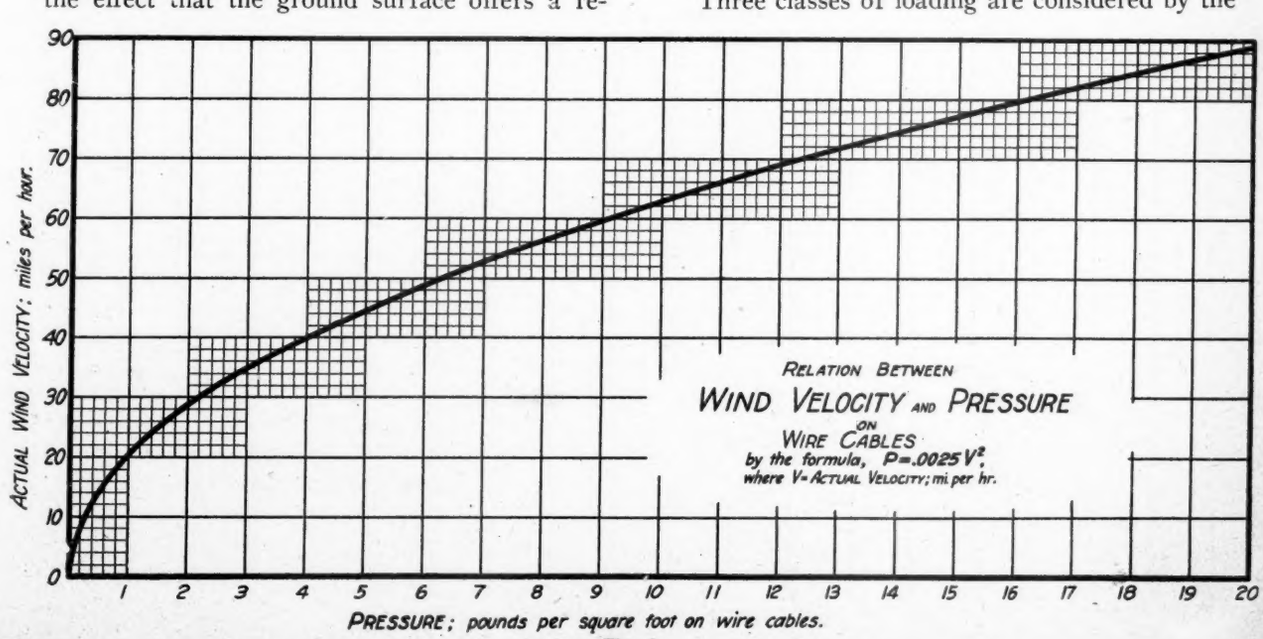


Fig. 2.

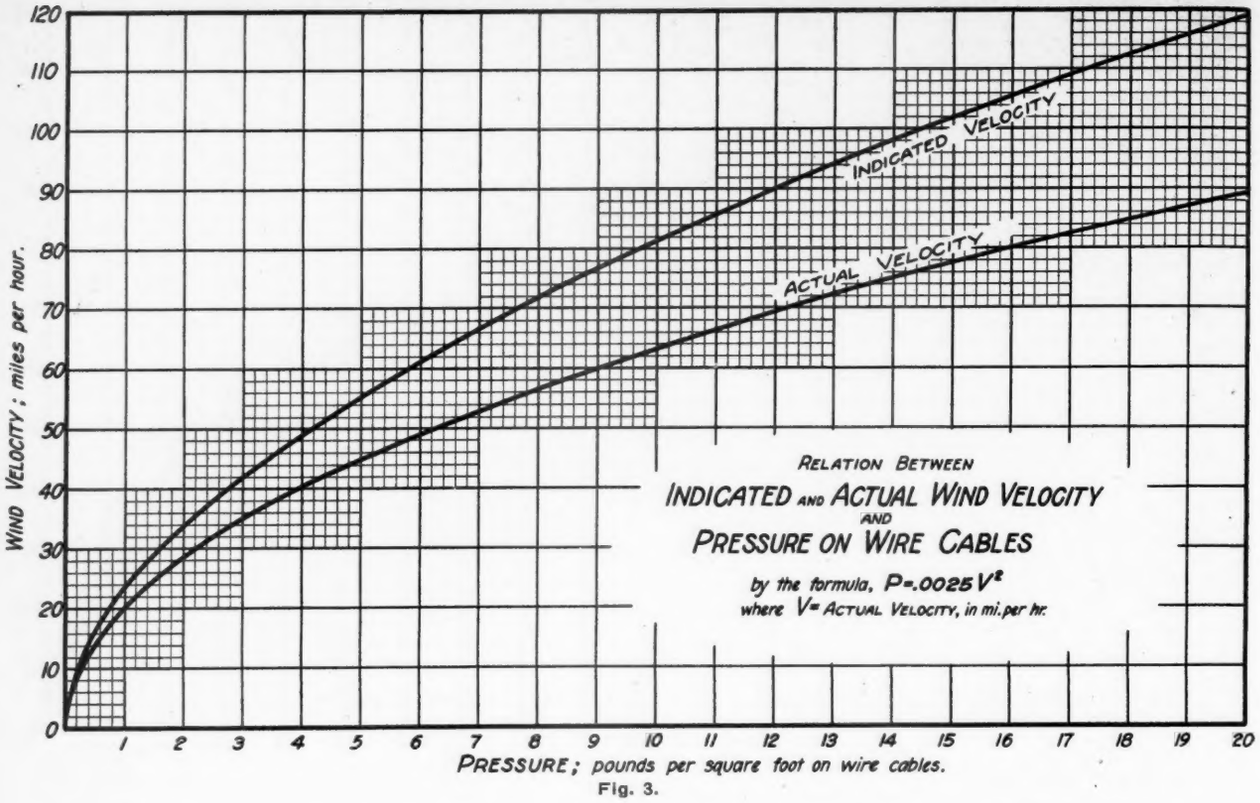

WIND VELOCITY; miles per hour.
INDICATED VELOCITY
ACTUAL VELOCITY
RELATION BETWEEN
INDICATED AND ACTUAL WIND VELOCITY
AND
PRESSURE ON WIRE CABLES
by the formula, P=.0025V²
where V= ACTUAL VELOCITY, in mi. per hr.
PRESSURE; pounds per square foot on wire cables.

Fig. 3.

Joint Committee on Overhead Crossings, as follows:

Class of loading.	Vertical component of load on wire.	Horizontal component of load on wire, or wind load across line.
A....	Dead	15 lb. per sq. ft.
B....	Dead + ½ in. ice	8 lb. per sq. ft.
C....	Dead + ¾ in. ice	11 lb. per sq. ft.

For the Class "B" loading the ordinary range of temperature is given as 20 to 120 deg. F.

For the calculation of pressures on supporting structures the requirements are 13 lb. per sq. ft. on the projected area of closed or solid structures, or on 1½ times the projected area of latticed structures. The same Joint Committee allows a maximum working stress on copper of 50% of the ultimate breaking stress; in other words, the wires may be stressed to a point very near to the elastic limit.

An analysis of these three classes of loadings would seem to suggest that Class "A" be used for lines in the extreme southern part of the United States, and that Class "B" be used for all other lines in this country, unless it be for a few lines which might be located in regions where especially cold weather is to be encountered, along with very severe wind storms. For such lines Class "C" would certainly be ample to take care of the most extreme conditions.

Interpreting these loadings in terms of wind velocities, Class "A" would allow for an indicated wind velocity of 101.8 mi. per hr., or an actual velocity of 77.46 mi. per hr., acting against the bare conductor. Class "B" provides for an indicated wind velocity of 71.96 mi. per hr., or an actual velocity of 56.57 mi. per hr., applied to the projected area of the wire covered with a layer of ice ½ in. thick all around. Class "C" assumes an indicated velocity of 85.9 mi. per hr., or an actual velocity of 66.33 mi. per hr., against the wire covered all around with a layer of ice ¾ in. thick.

It has been contended by some engineers that sleet does not deposit readily on aluminum, owing to the greasy character of the oxide which forms on the surface of aluminum conductors, and that because of this fact the wind loads acting on such lines should not be taken so high as when copper wires are used. But the experience and observation of many other engineers does not confirm this assumption.

This is the first of a series of articles by Mr. Gemmill on transmission towers. The next article, which will appear in an early issue, will deal with present theory and practice in regard to transmission spans.

ELECTRICAL EQUIPMENT FOR MINES DISCUSSED AT SEATTLE.

The Seattle Section of the American Institute of Electrical Engineers held a regular session Feb. 17, with G. E. Quinan presiding. A feature of the meeting was a paper by E. J. Barry, electrical engineer, Tacoma, on "Electricity in Pierce County Coal Mines." In this paper the problems concerning the installation and operation of electrical equipment in and around coal mines were discussed, and the armored cable in the Wilkeson mine was described in detail. In the discussion that followed, G. E. Quinan called attention to electrical equipment of the metal mines in the Coeur d'Alene mining district of Idaho.

Amos Slater, president of the Associated Engineering Societies of Seattle, announced a conference of engineers of Oregon, Washington, Idaho and Montana, at Seattle on April 6 and 7, to discuss the proposed Department of Public Works by Congress.

Grounding and Polarization as Protecting Measures—Part II

Why and How Certain Electrical Circuits Should Be Grounded in Order to Afford Protection Against Fire and Life Hazard

By W. J. CANADA

This is the second and concluding installment of an article on this timely subject. Through his connection with the United States Bureau of Standards some years ago, Mr. Canada gave much thought and made extensive investigations on grounding and polarization of low-voltage electrical circuits for the purpose of formulating rules for inclusion in the National Electrical Safety Code. His present work as chairman of the Committee on Grounding, Electrical Committee, National Fire Protective Association, qualifies him to be quoted as an authority on the subject, which will undoubtedly receive major consideration at the March meeting of the Electrical Committee for revision of the National Electrical Code.

In the first installment, which appeared in last week's issue, Mr. Canada discussed the question of what and why certain circuits should be grounded. This installment is a continuation of the latter subject, with his conclusions on how they should be grounded.—EDITOR'S NOTE.

Besides grounding certain circuits, we should also ground certain equipment frames, the criteria here also being: Is there a possibility of unsuitably high voltage and will grounding prevent it? Here there is no intention of having any voltage to ground, so that any appreciable voltage is unsuitable, the degree of unsuitability and danger varying, of course, with the voltage and with the location of the equipment with reference to premises and persons. Equipment frames, where for use by the public, are designed to be at the same potential as surrounding objects in the premises, including persons. Therefore it is clear that the provision of insulating supports for such frames can be considered as reducing the unsuitability of any voltage to ground only where the equipment is so far out of reach of persons and processes that no probability exists that contacts with the equipment frames by persons or implements could supply a connection between the ungrounded frames and the ground itself.

GROUNDING EQUIPMENT FRAMES.

As to the degree of desirability of grounding where unsuitable voltage may otherwise exist on equipment frames, this depends on the likelihood of contacts between such frames and persons or partly grounded objects, on the difficulty of grounding and on the degree of danger in case of contacts. With the higher voltages all equipment frames should be grounded. The Code does not explicitly make this general requirement, but the trend of the Code is shown by certain specific rules on grounding of motor and generator frames for voltages above 550, and on grounding of all cable and conduit lengths supplying motors above 550 volts. The lack of explicit rules for much other desirable frame grounding at different voltages and under different conditions is a very regrettable deficiency of our generally excellent wiring Code. We shall no doubt correct it in future issues.

Some devices like fixture frames are specifically exempted from grounding even at the higher voltages, and are even required to be insulated. As someone has plainly put it, this assures that the fixture frame, if it becomes alive through its constant exposure from the live wires within, will remain at a dangerously high voltage indefinitely. The Code has delayed a change of this rule, but this has been much discussed, generally supported and may be expected in future revisions. A number of device frames, like metal switch boxes on open or concealed knob wiring, rheostat frames, and some others, are exempted from grounding requirements only by failure to include rules. The fact that such devices are circumscribed in extent of frame exposed to chance contacts of persons or things, as compared to conduit, is one circumstance partly excusing lack of grounding requirements at the lowest commercial voltages, but certainly not at higher voltages. Another partial excuse is in the supposed difficulty of reaching a ground. This difficulty is, of course, no greater than with motors, and the hazard for equal voltages is fully as much if not grounded. But the cost of grounding is relatively less for the larger cost of the motor. This brings us to a very real and proper objection to grounding of equipment frames in certain instances—the unwarranted cost.

INFLUENCE OF COST ON GROUNDING.

It seems axiomatic that if a hazard is very small and the cost of avoidance very large, insistence on the protective measure may militate against the use of electric service which even with the hazard is much safer than any substitute. The cost should not rashly be increased in the face of this fact. Usually it is possible with lower voltages, say, up to 150 volts to ground of the contained wires, sufficiently to isolate equipment from persons and processes and from grounded surfaces so that the hazards to premises and persons caused by not grounding are negligibly small; and this applies to switch boxes, small motors, lighting fixtures, pendant sockets and other small devices. Objection to either grounding or isolating is not at all justifiable. The present Code rules, however, are at present a blank on most of these devices and allow any leeway the wiremen desire as regards grounding.

For portable devices, unfortunately, the

grounding of frames is not only difficult and relatively expensive, but it cannot yet be made as reliable as can grounding of fixed frames, partly because of lack of sufficient development in terminals of fittings for the connection of the ground conductor both at the device and at the fixed terminal. Grounding protection is, of course, the more desirable because of the relatively frequent handling of portable devices, but in the absence of reliable means of grounding the next best safeguard is the limitation of voltages for which such portables may be employed. This limit is set at 300 by the Code and probably should be lower, say 150 to ground. It may be noted as one of the points not yet fully covered by the Code rules on grounding that a 220-440 volt a-c. circuit may be left ungrounded according to the rules, and may have portable fittings, brass-shell sockets, switch casings and lighting fixtures whose frames are entirely ungrounded, although exposed constantly to the unsuitable voltages of the circuit itself and of the exposing circuits.

Reasons for Polarizing Circuits.

Having now briefly outlined the reasons for grounding both circuits and equipment frames, it will be well also to examine into the reasons for polarizing. It is clear that in sockets and probably some other current-consuming equipments supplied through two or more wires the chance of insulation failure between one pole of the fitting and the frame will be greater than that between other poles and the frame, due to closer proximity, more sparking or other causes. In a socket the screw shell is more likely to leak to the outer brass shell than the center contact. It is desirable, therefore, that the voltage to earth of the screw shell should be as little as practicable, both to minimize the stress on the insulating lining and to minimize the hazard to persons and premises in event of breakdown. This protection can be afforded, where the circuit is grounded, by attaching the screw shells of all sockets to the grounded wire. To assure such connections necessitates the identification of the grounded wire, or, in other words, the polarization of the wiring system. By such identification the system, from the time of its original installation and through all its repairs continues, if handled with only reasonable care, to indicate which wire should be connected to certain devices to minimize the likelihood of their frames having unsuitable voltages imposed upon them.

If through any oversight or carelessness the identified wire is at any point connected to an unidentified wire or a wrong connection is made at a fitting there is no added hazard which would not have existed in an unpolarized circuit. There is only a possible loss of the protection afforded by the polarization, as follows: (1) The grounded circuit might be grounded in error at a point which does not secure the minimum voltage to ground of the circuit itself, although protecting fully against leakage from exposing circuits. Such a wrong ground connection is, of course, far less likely to happen than with present unpolarized circuits. (2) The fittings may not be polarized as intended and may thus be exposed to insulation breakdowns to a greater degree than where polarization is effectively carried out, but to no greater degree than is now common to unpolarized circuits.

As there may be some still seriously interested in concentric wiring, it may be well to note that the identified wire recommended, and covered by the Code rules, has an insulating covering the same as any other wire. Thus any error in connection, such as is recognized as likely to occur occasionally, will not bring about the serious hazards which would result from erroneous connection of a concentric wire sheath.

How Should Protective Grounds Be Made.

Passing now to the final question, we ask how should protective grounding be performed. This requires a clear definition of grounding and this may be said to be a connection to the ground of sufficiently low resistance (short for impedance) and of sufficient reliability. "Ground" needs also to be defined as that portion of the ground in the vicinity of any portion of the equipment or circuit to be grounded. It is only those closely adjacent parts of the ground which can, in conjunction with the ungrounded circuit or equipment, cause a hazard to premises or persons. With equipment the place to ground is determined by the location of the equipment, being the nearest place where a metallic piping of reliable continuity is extended from a piping system into the building in the vicinity of the equipment.

With a motor or other fair-sized equipment this would mean the nearest water connection, the degree of reliability against interruption of this connection being adequate and the hazard to persons and buildings by lack of grounding protection coming wholly from these pipes and similar extensions of the ground in the vicinity of the equipment.

Grounding of Lighting Fixtures.

With lighting fixtures the ground connection should be also to an adequately reliable extension of the ground into its vicinity. Metal ceilings may have leakage to ground through damp walls, chance contacts with pipes or building reinforcement, but they make mighty unreliable ground connections for fixtures. At the same time they furnish the best of reasons for fixture grounding, even where the fixture is out of reach of the public. For fixtures the ground connection can be made through a neighboring water pipe or through a gas pipe if this is properly bonded at its service to the more reliable water piping. Or the ground may be made to the conduit supplying the fixture. If the fixture is served by knob-and-tube wiring it will frequently be advisable to run a ground wire some distance rather than leave an ungrounded fixture to the vicissitudes of painters, movers, repair men, cleaners and decorators, who may disturb the canopy insulation, drape the fixture with conducting wires or threads, or otherwise materialize the inherent danger of such ungrounded devices. As before noted, the Code does not as yet require the grounding of lighting fixtures. In fact, it now requires a better fixture when grounded than when left without this protection, and this regardless of the surroundings.

Conduit, of course, as well as other wire runways, can be grounded with comparative con-

venience, since it usually extends to places near water piping. Short lengths, however, may involve as much inconvenience and cost as lighting fixtures. If entirely away from grounded piping, damp walls, metal ceilings or other surfaces which may be in more or less good contact with the ground and out of the way of persons in contact with grounded surfaces, such conduit, of course, need not be grounded for safety and more than lighting fixtures similarly situated. The Code does not now draw the distinction between safe and unsafe locations very logically, but it does permit short lengths of conduit to be ungrounded. It requires grounding, however, for service conduits, unless out of reach or containing no wires above 150 volts to ground.

Grounding of Circuits.

Circuit grounding presents a different problem from equipment frame grounding in that the circuit is much more widely extended, often entering many different premises. It involves more hazard and needs a more reliable ground than may be necessary for the equipment frame. Reliability may be multiplied by multiplying the number of ground connections, but there are some limitations in addition to extra cost of these many connections.

With d-c. circuits the grounded wire, usually a neutral, carries direct current and two grounds at different points divert some of this through buried metallic structures with possibility of electrolytic damage. For this reason multiple grounds on such circuits are prohibited by the rules, although, to be sure, two or more accidental grounds are likely to occur on the same d-c. wire whether grounded or not. The loss in assurance of protection by limitation to a single ground is small since these circuits usually start from attended stations where the operator with his instruments can assure the continued effectiveness of the single ground.

With a-c. circuits also, two or more grounds at different points will divert some current through the soil and buried structures, but such circuits are usually of far less extent than d-c. circuits and have a great deal less voltage drop in the grounded wire. Even were these stray currents considerable and long continued, the electrolytic effects on buried metallic structures would be negligible. The advantage of multiple grounds is not so great, however, that they should be made on small circuit wires at points within any one building additional to the single ground at the building service entrance. This might impose an earthing current on some small circuit wire larger than it is designed to carry.

Location of Grounds.

Since circuits extend from building to building, a greater choice is offered of locations where the ground connection or connections may be made than with equipment grounds. This wide choice has had some bad effects, however, in obscuring in some minds the real object of circuit grounding, which is to assure a minimum voltage between the grounded objects in premises and the circuits entering these premises. There has been some tendency to insist that the grounding of circuits away from the buildings served is just as good. This is untrue. The grounded objects most prevalent in premises in the vicinity of circuit wiring are the plumbing fixtures connected to water piping, and this piping system offers the best and most reliable protective connection to earth for reasons which are apparent on the briefest consideration. Other grounded objects exist in buildings, such as damp walls, floors and poorly grounded piping, but these offer no reliable low-resistance ground connection with circuits although they impose hazards where near ungrounded circuits. The whole object of circuit grounding—the prevention of undue voltage—is most fully attained by connection to water piping systems.

Just where on a water system such ground connections are to be made is dependent wholly on the ease of making proper connections and of maintaining them. For the single ground of a d-c. system, connection to the general water piping system near the station is advisable. For the multiple grounds of an a-c. system the multiple water services of the premises entered both by circuits and water piping offer the best connections.

For the cases where a-c. circuits enter buildings which lack water piping, these circuits can be grounded elsewhere to such water piping as the best connection to the earth itself and the best assurance against undue voltage between these circuits and the various damp floors, walls and poorly grounded piping in these buildings. If the circuit is in no place near to a buried water system, resort must be to some other means of securing a good, low-resistance connection with earth. Usually such connection must be an artificial one. Driven pipes, plates and strips of wire, laid or driven below moisture level in a fairly conducting soil (that is, one containing a considerable amount of soluble salts) will supply a ground connection of resistance low enough to protect secondaries from the high voltage windings of properly fused small transformers, where the secondaries are not otherwise exposed. A 20-ohm artificial ground will protect a secondary from a properly fused 2-kw. transformer so long as the ground continues intact.

Use of Artificial Grounds.

Some artificial grounds have a measured resistance of 2000 ohms and would protect against an entirely ungrounded primary of very small extent only. Any artificial ground should be viewed with suspicion until measured and check should be made after it is in use. A multiplicity of such grounds is almost a necessity, though still left optional in the Code.

It is very fortunate that water systems do extend into most buildings having a-c. wiring systems, since the connection between these two systems is the best assurance to the premises and occupants against high voltage and such a connection is both harmless and inexpensive. Unless connected to the secondary circuit, the water piping adds a serious danger to the premises. On the other hand, each additional multiple ground of this kind on a circuit has the advantage of adding to the assurance against loss of protection both to the particular premises grounded and to all others on the circuit, and of additionally assuring waterworks employes or plumbers

handling the water piping against any voltage between the circuit and the piping in case where any one ground connection is necessarily removed to permit repairs to the piping.

With either the single ground at the station, which is desirable for d-c. circuits, or the multiple grounds at premises served which are desirable for a-c. circuits, the ground resistance should be low and the ground itself continue intact. No joint should exist where avoidable, and, where unavoidable, as at connections between the ground conductors and the water piping, properly prepared surfaces and reliable clamps or screw joints should be used. Ground connections to water services have the great advantage of providing readily accessible and easily inspected joints. The driven pipe ground also has this advantage, whereas in plate grounds the joint between conductor and plate is buried.

It has been suggested that the distinction is not clear in some minds as to why the Code calls for grounding of d-c. circuits of any voltage if exposed by high-voltage circuit, yet prohibits the connection of interior wiring to grounded trolley systems. The distinction is simple. The grounded trolley system is not required by the Code to be grounded as a safety measure, and it is not grounded for that reason but because it is impractical to insulate it. Furthermore, it is not grounded in the manner and with the precautions required for protective grounding of d-c. circuits. Its numerous rail leakages to earth multiply the chances of trouble on interior wiring circuits fed by grounded trolley systems. The amounts of current are also very large and the frequency of short circuits such that circuit-breakers are closed at stations after opening under heavy loads and thus harmful short-circuits in buildings are likely to be repeatedly restored and the damage increased.

The Code requirement for grounding circuits has nothing whatever to do with such conditions as these.

This brief statement of the "what," "why" and "how" of protective grounding necessarily leaves much unsaid which may appear important to some inspectors in the light of varied individual experience with the problem. I think it would be very helpful if representatives of the lighting companies, the inspectors and the water companies would bring forward phases of the problem which to them appear important or difficult. It is hoped that this paper will serve to stimulate a full discussion of grounding, for free discussion is the best means of ascertaining facts and clearing mysteries.

MUNICIPAL PLANT REPLACED BY OUTDOOR SUBSTATION.

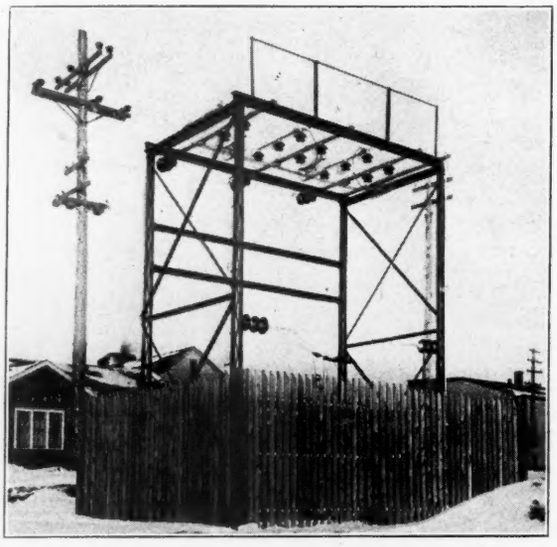
Features of New Substation Installed to Provide Service to the Village of Grand Rapids, Minn.

The difficulties encountered in maintaining adequate fuel supplies and competent labor have been responsible for many interruptions to the service of small generating plants, especially in municipalities. The abnormal changes in operating conditions have also tended to make operation of these plants unprofitable, and the solution of such problems has been, when transmission lines of a power company are nearby, to build the necessary connecting line and purchase power at wholesale.

An illustration of this is given in the case of the village of Grand Rapids, Minn., which recently discontinued the operation of its 150-kv-a. municipal plant and entered into a contract with the Minnesota Utilities Co., of Chisholm, Minn., for the purchase of power from the company's 22,000-volt transmission system.

A steel tower outdoor substation was built, the initial capacity of which is 150 kv-a. The three 50-kv-a., 22,000/2200-volt, single-phase transformers are connected in closed delta, and the design and equipment of the substation is such that three 200-kv-a. units can be installed at a future date, the only change needed being in the ampere capacity of the high-tension fuses. The steel tower occupies a ground area of 15 ft. by 8 ft. 6 in., and the height is 20 ft.

The high-tension control and protective equipment consists of a three-phase combination, remote-control, manually operated, double-break-per-phase switch, carbon-tetrachloride fuses and long-turn cylinder-form choke-coil unit mounted at the top of the tower. The three-pole switch is of the interlocking form, operated by means of a locking type handle at ground level. The incoming side of the substation tower is equipped with two cross members for future mounting of three single-pole disconnecting switches for lightning arresters, in case it should be decided to install them at a future date.



New Outdoor Substation for Supplying Service to the Village of Grand Rapids, Minn.

Approximately 400 ft. distant from this installation is a 1500-kv-a. step-down substation connected to the same line and equipped with electrolytic lightning arresters. Consequently it was not thought necessary to install arresters at the 150-kv-a. station, but provision is made for them should their future use be warranted.

The 2200-volt town distribution lines are connected in the usual manner through the equipment used with the original generating plant.

Transformers for the installation were supplied by the Pittsburgh Transformer Co., and the unit type substation by the Delta-Star Electric Co., Chicago.

Last Stand of the Reciprocating Steam Engine

Electric Motors Predicted to Replace Reciprocating Steam Engines in Railway Operation—Paper Before Schenectady Section, A. I. E. E.

By A. H. ARMSTRONG
Chairman, Electrification Committee, General Electric Co.

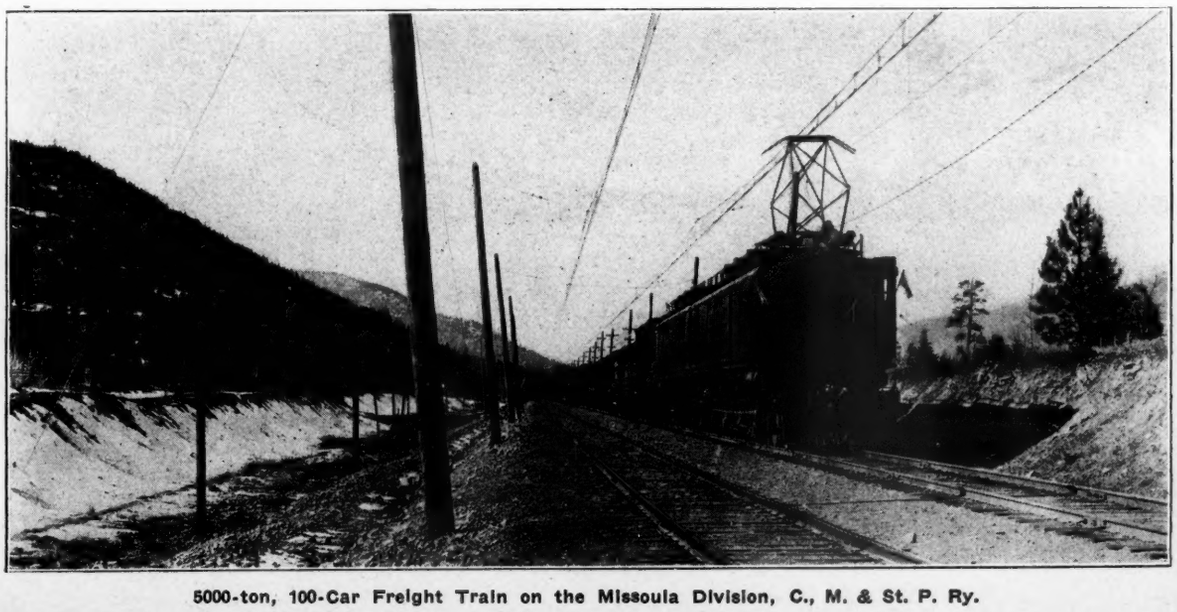
During 1920 the people of the United States will pay out for pleasure vehicles a sum of money considerably greater than the estimated requirements of our steam railways for that year. The railways, however, may find it very difficult to secure the large sums needed without government aid, notwithstanding the fact that the continued operation and expansion of our roads is of vital necessity to the welfare and prosperity of the country. The will of the American public has always been constructive and undoubtedly its voice will be heard and properly interpreted by its representatives in Washington with the resulting enactment of such laws as will permit our railways again to offer an attractive field for the investment of private capital.

The purpose of this paper is not to discuss the politics of the situation nor any necessary increase in freight rates that may be required to make our roads self-sustaining, but rather to offer certain suggestions as to the best manner of spending the sums that must ultimately be provided for new construction and replacements.

During the winter of 1917-18 our railways fell down badly when the need for them was the greatest in their history. It is true that the cold weather conditions were unprecedented and the volume or traffic abnormal, but the weaknesses of steam-engine haulage were disclosed in almost startling and disastrous manner. Delayed passenger trains in cold weather can be endured but the blocking of tracks with frozen engines, resulting in a serious reduction of tonnage in cold weather and a prohibitive delay in transportation of freight in times of great stress, is quite another thing and plainly indicates the inability of the steam engine to meet overloads and adverse climatic conditions.

In marked contrast to the adjoining steam-engine divisions, the 440-mile electrified section of the Chicago, Milwaukee & St. Paul Railway continued to operate as usual all through that trying winter of 1917-18. The electric locomotives brought both freight and passenger trains over the tracks in schedule time or better; in fact, it was quite customary to make up on the 440-mile electric run fully two hours of the time lost by passenger trains on adjoining steam-engine divisions. While the results obtained were perhaps more spectacular, due to the greater mileage electrically equipped, other electrified roads contributed similarly attractive records. The reliability and permanency of the comparison between steam and electric locomotive haulage is sufficiently guaranteed, therefore, by the results of several years' operation, to justify drawing certain conclusions regarding the merits of the two types of motive power. The following analysis of the railway situation is, therefore, offered for the purpose of exposing the fact that railroading today is in reality steam-engine railroading and the general introduction of the electric locomotive will permit fundamental and far-reaching changes being made in the method and cost of hauling freight and passenger trains.

The immediate electrification of all railways in the United States is not proposed, as many roads



5000-ton, 100-Car Freight Train on the Missoula Division, C., M. & St. P. Ry.

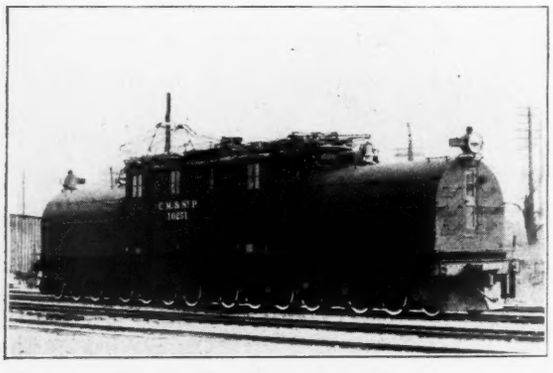
of lean tonnage would render no adequate return upon the large capital investment required, but the following table of total operating statistics is offered simply as a measure of the magnitude of the problem to be confronted in the future. In this country it should be noted; however, that there has been installed during the past 30 years electric power stations equal to twice the estimated capacity required for the electrical operation of all the railways.

The tonnage passing over these railways may be subdivided as shown in the accompanying table. The first four items, representing 85.56%

Total Ton-Mile Movement of All Railways in United States for 1918.

	Ton-miles.
1 Miscellaneous freight cars and contents..	515,000,000,000
2 Revenue coal cars and contents.....	197,000,000,000
3 Locomotive revenue, driver weight only	132,300,000,000
4 Passenger cars, all classes.....	196,000,000,000
Total revenue, freight and passenger..	1,040,300,000,000
5 Railway coal	60,600,000,000
6 Tenders, all classes.....	78,800,000,000
7 Locomotive railway coal.....	4,700,000,000
8 Locomotive, non-driving weight.....	31,000,000,000
Total non-revenue	175,100,000,000
Grand total (all classes).....	1,215,400,000,000

of the total ton-miles made during 1918, may be regarded as fundamentally common to both steam and electric operation. By introducing the electric locomotive, however, the last four items are reduced to the extent of completely eliminating items 6 and 7, reducing item 5 by possibly 80% and item 8 by 50%. Of the total of 14.64% affected, therefore, it may be assumed that approximately 12% or 146,000,000,000 ton-miles, at present hauled by steam engine, will be totally eliminated with electric locomotive haulage. This ton-mileage eliminated is equal to over 20% of items 1 and 2, representing the revenue producing freight traffic on our rail-



High-Speed Gearless Passenger Locomotive for the C., M. & St. P. Ry. 3000-Volt Direct Current Electrification.

ways. In other words, if all the railways were completely electrified they could carry one-fifth more revenue-producing freight tonnage with no change in present operating expenses or track congestion.

It is evident that the greater part of the tonnage reduction effected by electrification is included in items 5 and 6, representing the railway-coal movement in cars and engine tenders. The steam-engine tender will, of course, entirely disappear, while the railway-coal haulage will be largely curtailed by utilization of water as a source of power and the establishment of steam powerhouses as near the coal mines as an abundant supply of good condensing water and load demand will permit. While water power should be utilized to the fullest economical extent, the greater portion of the railway power must undoubtedly be supplied by coal, due to the unequal geographical distribution of water power available.

Even with coal as the source of power, it may not be fully appreciated just how enormous is the saving made by burning fuel in large modern power stations under the most efficient conditions possible, instead of under the boilers of 63,000 engines which by necessity must be designed and operated for service rather than for fuel economy. During 1918 the fuel used by railways is reported to be as follows:

Railway Fuel for 1918.

Total coal production (all grades).....	678,211,000 tons
Used by steam railways.....	163,000,000 tons
Percentage of total.....	24 per cent
Total oil marketed in United States.....	355,927,000 bbls.
Used by steam railways.....	45,700,000 bbls.
Percentage of total.....	5.8 per cent
Coal equivalent of oil at 3½ bbls.....	13,000,000 tons
Total equivalent railway coal.....	176,000,000 tons

A quarter of all the coal mined in the United States is consumed on our railways and the following analysis will point out some features of this extreme wastefulness which are inseparable from steam-engine operations.

During 1910, exhaustive tests were made upon the Rocky Mountain Division of the Chicago, Milwaukee & St. Paul Railway to determine the relation existing between the horsepower-hours work done in moving trains and the coal and water consumed on the steam engines in service. Following are the results of these tests:

Coal and Water Used on Rocky Mountain Division, C., M. & St. P. Railway.

	Water per hp-hr.	Water per lb. coal.	Coal per hp-hr.
Three Forks-Piedmont.....	39.6	5.08	7.75
Piedmont-Donald	35.4	4.70	7.54
Deer Lodge-Butte	39.7	4.85	8.31
Butte-Donald	40.4	4.86	8.74
Harlowtown-Janny	38.0	4.09	8.90
Janny-Summit	44.2	4.65	9.48
Three Forks-Piedmont	41.4	6.51	6.37
Piedmont-Donald	40.2	5.63	5.78
Average of eight tests.....	39.86	5.04	7.86

The records were obtained during the portion of the runs that the engines were doing useful work in overcoming train and grade resistance; that is, all standby losses were excluded. The through run, however, included these losses:

Standby Losses.

	Coal per hour.
Fire banked in roundhouse.....	150 lbs.
Cleaning fires for starting.....	800 lbs.
Coasting down grade.....	950 lbs.
Standing on passing track.....	500 lbs.

Adding standby losses to the average of 7.86 lbs. per hp-hr. obtained in the preceding eight tests, the total actual coal consumed under the engine boiler in 24 hours divided by the actual work performed by the engine is found to be 10.18 lbs. per hp-hr. at the driver rims.

As the result of this particular series of tests it was determined that the coal consumed while doing useful work was raised 30% by standby losses. It should be appreciated in this connection, moreover, that this value was obtained on through runs with no yard-switching service or adverse climatic conditions. It may be concluded, therefore, that under all conditions of service fully one-third the coal burned on steam engines

today is absolutely wasted in standby losses of the general nature indicated above.

Supplementing these tests, a 30-day record was kept of all coal used on the entire Rocky Mountain Division and the total engine, tender and train movement reduced to hp-hrs., resulting in a value of 10.53 lbs. coal consumed per hp-hr. at the driver rims. Both the above values were based upon constants of 6 lbs. per ton train resistance at all speeds and 0.7 lb. per ton per degree of curvature as determined in part by dynamometer car tests and representative of general railway operation. Reducing the average coal values of the test runs and the 30-day record per hp-hr. to electrical constants, the following data is obtained.

Coal Equivalent Per Kw-hr.—Steam Operation.

Coal per hp-hr. at driver rims	10.27 lbs.
Coal per kw-hr. at driver rims	13.75 lbs.
Coal per kw-hr. at power supply on basis 55% efficiency	7.56 lbs.

It is this last figure of 7.56 lbs. of coal burned on steam engines to get the equivalent tonnage movement of 1 kw-hr. delivered from an electric power station that is of special interest to this discussion. Comparing coal and electrical records on the Butte, Anaconda & Pacific Railway before and after electrification results in arriving at a value of 7.17 lbs. of coal previously burned on the steam engines to equal the same service now performed by 1 kw-hr. input at the substations, a figure comparing favorably with 7.56 lbs. above arrived at by an entirely different method.

Analysis of Roundup Coal Used.

	Per cent.
Fixed carbon	49.26
Volatile carbon	38.12
Ash	7.74
Moisture	4.88
B.t.u.	11,899

Taking due allowance for the fact that roundup coal is somewhat low in heat units, it is nevertheless within the limits of reasonable accuracy to assume that the steam engines operating over the railways are consuming coal at a rate closely approximating 12.75 lbs. per kw-hr. of useful work done, as measured at the driver rims or 7 lbs. per kw-hr. as measured at a power station and including for convenience of comparison the transmission and conversion losses inherent to electrical operation.

An electric kilowatt can be produced for so much less than 7 lbs. of coal that we are now in position to finally forecast the approximate extent of the coal economy that would result from electrification.

Relation Between Kw-hr. and Ton-Miles—C., M. & St. P. Ry.—Avery to Harlowton, 1918.

	Passenger.	Freight.
Average weight locomotive	300 tons	284 tons
Locomotive miles, 1918	651,000	1,431,500
Locomotive ton-miles	195,000,000	407,000,000
Trailing ton-miles	434,406,000	2,903,099,000
Total ton-miles	629,406,000	3,310,049,000
Kilowatt-hours	24,890,000	105,287,000
Watt-hours per ton-mile	39.6	31.9
Ratio locomotive to total	31%	12.3%
Watt-hours per ton-mile combined movement	33.2	
Ratio locomotive to total combined movement	15.25%	

All power values in the above table are given at the point of supply from the Montana Power Co. at 100,000 volts and include deductions made for the return of power due to regenerative braking of the electric locomotives on down grades, amounting to approximately 14% of the total. Owing to the excessive rise and fall of the profile of the electrified zone and the C., M. & St. P. Ry., its operation is materially benefited by regenerative electric braking and the value of 33.2 watt-hrs. per ton-mile for combined and passenger movement should possibly be raised to the round figure of 40 to make it apply more nearly to conditions universally obtaining on more regular profiles. Hence, referring again to the ton-mile values given in the first table:

Total ton-miles, 1918	1,215,400,000,000
Watt-hours ton-mile	40
Kw-hr. total movement	48,700,000,000
Coal required at 7 lbs. per kw-hr.	170,000,000 tons

The actual equivalent coal consumed in the steam railways for 1918 is given as 176,000,000 tons, closely approximating the figure of 170,000,000 tons estimated above from the operating results obtained on the C., M. & St. P. electrified zone. These several values check so closely as to justify the completion of the fuel analysis of the railways as shown below:

Coal Saving by Electrification.

Total ton-miles steam	1,215,400,000,000
Reduction by electrification	146,000,000,000
Total ton-miles electric	1,069,400,000,000
Kw-hr. electric at 40 watts	42,776,000,000
Coal on basis 2½ lb. per kw-hr.	53,500,000 tons
Equivalent railway coal 1918	176,000,000 tons
Saving by electrification	122,500,000 tons

The startling conclusion arrived at is that approximately 122,500,000 tons of coal, or more than two-thirds the coal now burned in 63,000 steam engines, would have been saved during 1918 had the railways of the United States been completely electrified along lines fully tried out and proved successful. Moreover, the estimate is probably too conservative because no allowance has been made for the extensive utilization of water power which can be developed to produce power more cheaply than by coal in many favored localities.

From figures given, the conclusions in the following table are arrived at in the matter of power station capacity required for complete electrification of the railways in the United States.

Railway Power Required.

Kw-hr. electric operation, 1918	42,776,000,000 kw-hr.
Average load, 100% load-factor	4,875,000 kw.
Power-station capacity at 50% load-factor	9,750,000 kw.

It appears therefore that approximately 10,000,000 kw. power-station capacity would have been sufficient to run all the railroads for 1918, or one-half the station capacity which has been constructed during the past 30 years.

Estimated Power-Station Capacity in United States in 1918.

Central stations	9,000,000 kw.
Electric railways	3,000,000 kw.
Isolated plans	8,000,000 kw.
Total	20,000,000 kw.

In the order of magnitude, therefore, it is not such a formidable problem to consider the matter of power supply for the electrified railways and it becomes evident also that the railway power demand will be secondary to industrial and miscellaneous requirements.

Such being the case, the question of frequency of electric power supply becomes of great importance, if full benefit is to be obtained from extensive interconnected generating and transmission systems covering the entire country. Indeed with the full development of interconnected

power systems supplying both railway and industrial load from the same transmission wires, the above assumption of 50% load-factor for the railway load can be materially bettered.

In this connection a method of limiting the troublesome peak load hitherto considered inherent to railway power supply has been in successful operation on the electrified C., M. & St. P. zone for the past year. With unrestrained peaks, the load-factor was approximately 40%, but this low value has been raised to nearly 60% by the installation of an inexpensive and most satisfactory device known as the power limiting and indicating apparatus.

Load-Factor Records on C., M. & St. P. Ry. During 1919.

	Per cent duration of peak.	Per cent load-factor.
April	6.4	59.3
May	4.6	56.1
June	1.6	56.5
July	0.7	55.6
August	4.1	54.7
September	9.5	58.8

These load-factor records cover the performance on the 220 miles of the Rocky Mountain Division supplied by seven substations controlled as a unit. A load-factor of nearly 60% brings the electric railway within the list of desirable customers and makes it possible for power companies to quote attractively low rates for power.

Returning again to the question of power supply, it is instructive to note the general trend toward a higher frequency as evidenced by the turbine and transformer sales of the General Electric Co. during the past decade.

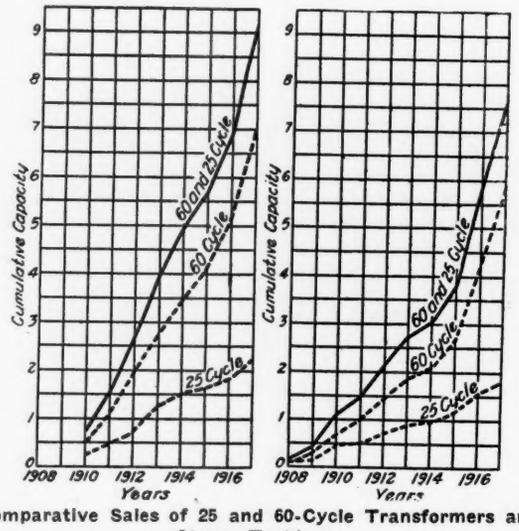
Adoption of Standard Frequencies.

It is quite evident that 60 cycles is rapidly becoming the standard frequency in America; and many instances are on record where it has replaced lower frequencies, principally 25 cycles. This fact in no manner handicaps the future development of electric railways, as entirely satisfactory power can be obtained from 60-cycle transmission lines through rotary converters or synchronous motor-generator sets, depending upon the d-c. trolley voltage desired. Indeed, a growing appreciation of the declining importance of 25-cycle power generation in this country contributed largely to the demise of the single-phase system, as its chief claim for recognition is wiped out with the introduction of the motor-generator substations required with 60-cycle supply.

While America apparently has adopted 60 cycles as its standard frequency and can look forward to unlimited interconnection of its large power systems, European practice is evidently crystallizing on 50 cycles. The situation abroad is as yet, however, not clearly defined. In such a small compact country as Switzerland, for instance, where so much electrical development is taking place, there is much conflict of frequencies. Apparently there is little appreciation of the advantages resulting from interconnected power stations; in fact, the Loetschberg Railway is supplied with power from 15-cycle waterwheel-driven generators placed in the same power station with 42-cycle units supplying industrial load, while in the same immediate district there is a 50-cycle transmission line and no tie-in frequency-changer sets as yet installed to interconnect any two frequencies. The power company, power consumer and electrical manufacturer pay heavily for the complication imposed by maintaining three frequencies where only one is needed, and growing appreciation of this fact may lead to the standardization of 50 cycles in Switzerland and thus swing that country in line with its neighbors and ultimately bring about a more economical ratio of installed generator capacity to average load demand for the country as a whole.

Comparison of Steam and Electric Locomotives.

From the power-station standpoint, the electrification of the railways in this country admits but one conclusion. There are some 63,000 engines now in operation and their average combined load amounts to approximately 4,000,000 hp. at the driver rims, or only an insignificant total of 65 hp. for each engine. Owing to shopping and other causes, a large proportion of these



Comparative Sales of 25 and 60-Cycle Transformers and Steam Turbines.

engines are not in active service at all times, still the average 24-hour output of each engine is less than 10% of its rating. In the case of the C. M. & St. P. electrification, the average load of each individual electric locomotive is only 15% of its continuous rating, but by supplying power to 45 electric locomotives from one transmission system, the average combined load-factor is raised to nearly 60%, a figure which could even be surpassed on roads of more regular profile. Furthermore, when the railway load is merged with the lighting and industrial power of the district and the whole diversified load supplied from the same 60-cycle transmission and generating system, it is quite evident that all the conditions are most favorable for the efficient production of power. In this country such an achievement will probably be governed by the laws of economic return upon the capital required because our vast natural fuel resources are popularly regarded as inexhaustible, but in Europe there is the compelling spur of stern necessity behind the movement to utilize economically the water powers they possess in place of the coal they cannot get.

While the much discussed subject of power generation and transmission is a very vital part of the railway electrification project, chief interest centers in the electric locomotive itself. Few realize what a truly wonderful development has

taken place in this connection in a comparatively few years and how peculiarly fitted this type of motive power is to meet the requirements of rail transportation. Free from the limitations of the steam boiler, and possessing in the electric motor the most efficient and flexible known means of transmitting power to the driving axles, the electric locomotive gives promise of revolutionizing present steam railway practice when its capabilities become fully recognized. The only limits placed upon the speed and hauling capacity of a single locomotive are those imposed by track alignment and standard draft rigging. Only questions of cost and expediency control the size of the locomotive that can be built and operated by one man, as there are no mechanical or electrical limitations that have not been brushed aside by careful development. Just what this means in advancing the art of railroading is as yet but faintly grasped, any more than the boldest prophet of 20 years ago could have fully pictured the change that has taken place at the Grand Central Terminal as the result of replacing steam by electricity.

Progress in utilizing the capabilities of the electric locomotive has been slow. It is hard to break away from life-long railway traditions established by costly experience in many cases. In consequence, the electric locomotive has thus far simply replaced the steam engine in nearly similar operation. Even under such conditions of only partial fulfillment of its possibilities, the electric locomotive has scored such a signal operating success as to justify giving it the fullest consideration in future railway improvement plans.

Reviewing the progress made in a short twenty-year period, we have seen the steam turbine and electric generator drive the reciprocating engine from the stationary power field. The same replacement is now taking place on our ships, big and small, notwithstanding the fact that the marine reciprocating engine is a very good engine indeed and operates under the ideal conditions of steady load and constant speed. And now the steam locomotive must in turn give way to the electric motor for the same good reason that the reciprocating steam locomotive has become obsolete and fails to respond to our advancing needs. Electrification affords a cheaper and better means of securing increased track capacity and improved service than by laying more rails and continuing the operation of still more steam engines in the same old wasteful way.

To conclude the startling picture of our present railway inefficiency, we are today wasting enough fuel on our steam engines to pay interest charges on the cost of completely electrifying all the railways in the United States, fuel that Europe stands in sad need of and which England and Germany, the pre-war coal exporting countries, cannot now supply. With operating expenses mounting to 82% of revenue, inadequate equipment and congestion of tracks, what we need, in addition to constructive legislation and real co-operation on the part of the government in the matter of rates and safeguarding invested capital is wise direction in the expenditure of the large sums that must speedily be found and used to bring our railways abreast of the times. Accord full honor to the reciprocating steam engine for the great part it has played in the development of our railways and industries, but complete the work by replacing it with the electric motor and enter upon a new era of real railroading, not restricted steam-engine railroading.

General Views of Grand Central Terminal, New York City, Before and After Electrification.

Development in Hydroelectric Practice

Review of Tendencies in Water-Power Plant Design, with Particular Reference to Water Turbines, Presented Before British Institution of Mechanical Engineers

Recent advances in utilization of water power formed the subject of a very comprehensive paper read by Eric M. Bergstrom before the Institution of Mechanical Engineers in London, England, on Jan. 23. He said that the water-power resources of the United Kingdom were well worth closer attention, and the fact that there was a large amount of water power existent in Canada, India, New Zealand, Tasmania and other parts of the British Empire awaiting development for both domestic and industrial purposes, imposed the necessity of more interest being devoted to this particular branch of engineering than hitherto.

The altered industrial position consequent upon the war added emphasis to the necessity for utilizing these wasting resources in the generation of cheap power for the manufacture of calcium carbide, nitrogen, aluminum, wood pulp and a large number of chemical products. In the coming struggle for industrial supremacy water-power engineering would play an important role; it was therefore desirable that the general knowledge of this highly specialized branch of engineering should extend over a very much wider circle than had hitherto been the case.

Mr. Bergstrom gave a synopsis of recent achievements and also reviewed the developments of water-power engineering from the beginning of the present century. He referred to the tremendous impulse which the development of water power received with the advent of the widespread application of electricity as a commercial basis and the perfection in system of transmission and distribution.

The accompanying Table I sets out the most representative installations built since 1895, and it indicates among other things the modern tendency of installing less units but of larger capacity than hitherto employed. The most representative turbine installations installed during the last 15 years are shown in Table II.

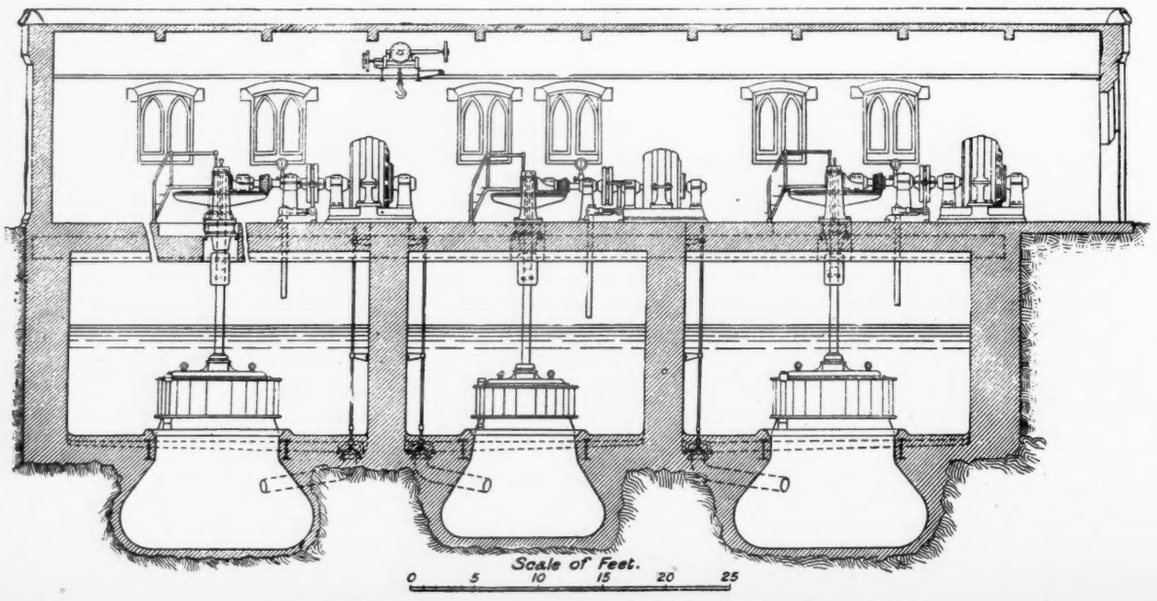
The author devoted a good deal of attention to the Francis turbine, its main characteristics, efficiency, runners, etc., and in Table III are given the most notable achievements in maximum efficiencies obtained during recent years. The figures represent results of tests in place under working conditions in the presence of impartial experts.

Descriptions of Representative Modern Hydroelectric Plants.

He followed with a brief description of some prominent modern hydroelectric power plants, embodying various types of turbines and modes of installation, to illustrate the advances in construction and general layout.

In describing the development of large single-runner Francis turbines for low heads, he emphasized that this development represented the most important advances in hydroelectric practice in recent years, and since its successful inauguration in 1912 it had been adopted in a number of prominent low-head plants including the Coosa River (Alabama), Cedar Rapids and Laurentide (Quebec).

The Chester (England) municipal hydroelectric power station is a typical extreme low-fall development operating under an average head of



Longitudinal Section of Chester (England) Hydroelectric Plant.

7 ft., although during certain periods of the year the head falls as low as 5 ft. and sometimes reaches a maximum of 9 ft. Accompanying are longitudinal and transverse sections of the Chester power house. The plant comprises two units each designed for 30,000 cu. ft. per minute, and one smaller unit to deal with 22,000 cu. ft. per minute, all under a maximum head of 9 ft., corresponding to an output of 415 hp. for the larger and 305 hp. for the small unit, the speed being 50 and 55 r.p.m., respectively. Each turbine is set in a rectangular concrete pit, with concrete-lined suction tube. The cast-iron regulating ring on the turbine is connected to each guide vane by means of pins and levers and is operated by hand from the power-house floor; the submerged guide bearing on the top of the casing is lined with babbit metal and grease-lubricated through pipes from the floor level. The vertical shaft is supported by a collar thrust bearing running in an oil bath and combined with the guide bearing to take the side thrust from the helical bevel wheels, which transmit the power through a flexible coupling to the direct-current generators arranged with horizontal shaft. The position of the power house is such that it is affected by

TABLE I—REPRESENTATIVE INSTALLATIONS BUILT SINCE 1895.

No.	Plant and Country.	Year of installation.	Working head in feet.	Output in B.h.p. per unit.	Number of units.	Speed in r.p.m.	Output under head = 1 ft.	Output per runner under head = 1 ft.	Type.
1	Cataract Construction Co., Niagara, U. S. A.	1895	136	5,000	10	250	3.15	1.575	Double inclosed vertical
2	A. B. Glommens Traesliberi, Christiania, Norway	1901	64.5	3,000	4	150	5.8	5.8	Single inclosed vertical
3	Shawinigan Water & Power Co., Montreal, Canada	1902	134	6,000	1	180	3.87	1.94	Double inclosed horizontal
4	Canadian Niagara Power Co., Canada	1903	133	10,250	3	250	6.68	3.34	Double inclosed vertical
5	Svalgfos Power Station, Natodden, Norway	1904	150	11,750	3	250	6.40	3.20	Double inclosed horizontal
6	Ontario Power Co., Niagara, Canada	1904	175	12,000	..	187.5	5.18	2.59	Double spiral horizontal
7	McCall Ferry Hydroelectric Power Station, U. S. A.	1905	53	13,500	10	94	35.00	17.5	Double open vertical
8	Great Western Power Co., U. S. A.	1907	525	18,000	4	400	1.5	1.5	Single spiral vertical
9	Trollhättan Hydroelectric Station, Sweden	1909	106	12,500	8	187.5	11.5	5.75	Double inclosed horizontal
10	Tokio Electric Light & Power Co., Japan	1910	396	12,500	6	...	1.6	0.8	Double spiral horizontal
11	Mississippi River Power Co., Keokuk, U.S.A.	1912	39	14,000	15	57.7	57.5	57.5	Single open vertical
12	Aelfkarleby Hydroelectric Power Station, Sweden	1914	54	14,000	5	150	35.4	8.85	Quadruple open horizontal
13	Cedar Rapids Power Station, Montreal, Can.	1914	30	10,800	12	55.6	66.0	66.0	Single open vertical
14	Alabama Power Co., U. S. A.	1914	68	17,500	6	100	31.0	31.0	Single open vertical
15	Laurentide Power Station, Canada	1915	76	20,000	6	120	30.0	30.0	Single open vertical
16	Tallahassee Power Plant, U. S. A.	1916	180	31,000	..	154	12.85	12.85	Single inclosed vertical

TABLE II—REPRESENTATIVE TURBINE INSTALLATIONS OF THE LAST 15 YEARS.

No.	Plant and Country.	Year of installation.	Net head in feet.	Output per unit in B.h.p.	Number of units.	Speed in r.p.m.	Type.
1	The Mexican Light & Power Co., Necaxa, Mexico	1903	1,279	8,200	6	300	4-jet vertical
2	Brusio Hydrcelectric Plant, Switzerland	1905	1,350	3,500	12	375	Single-jet horizontal
3	Rio de Janeiro Tramway, Light & Power Co., Brazil	1906	950	9,000	6	300	4-jet vertical
4	British Aluminum Co., Ltd., Kinlochleven, Great Britain	1907	900	3,300	11	300	Double-jet horizontal
5	Tysse Hydroelectric Plant, Norway	1907	1,260	4,800	7	375	Single-jet horizontal
6	Rjukanfos Hydroelectric Plant, Station I, Norway	1908	930	14,450	10	250	4-jet twin runner horizontal
7	Loentch Hydroelectric Plant, Switzerland	1908	1,075	6,000	4	375	Double - jet overhanging horiz.
8	The Mexican Light & Power Co., Extension, Mexico	1909	1,279	16,000	2	300	4-jet vertical
9	Biashina Hydroelectric Plant, Switzerland	1909	850	11,000	3	300	4-jet vertical
10	Southern California Edison Co. Kern River Plant I, U. S. A.	1910	865	10,750	4	250	2-jet twin runner overhanging horiz.
11	Lake Bunzen Hydroelectric Plant, Station II, Canada	1912	395	13,500	3	200	8-jet quadruple runner horiz.
12	Kinugawa Hydroelectric Plant, Japan	1912	1,050	6,000	6	375	Single-jet horizontal
13	Rio de Janeiro Tramway, Light & Power Co. Ext., Brazil	1912	950	20,000	2	300	4-jet vertical
14	Loentch Hydroelectric Plant Extension, Switzerland	1913	1,150	16,000	1	300	Double - jet overhanging horiz.
15	Tata Hydroelectric Plant, Bombay, India	1914	1,650	13,500	6	300	Single-jet horizontal
16	Rjukanfos Hydroelectric Plant, Station II, Norway	1914	830	16,400	10	250	4-jet twin runner horizontal
17	Aura Hydroelectric Plant, Norway	1916	2,350	23,500	6	250	Single-jet horizontal

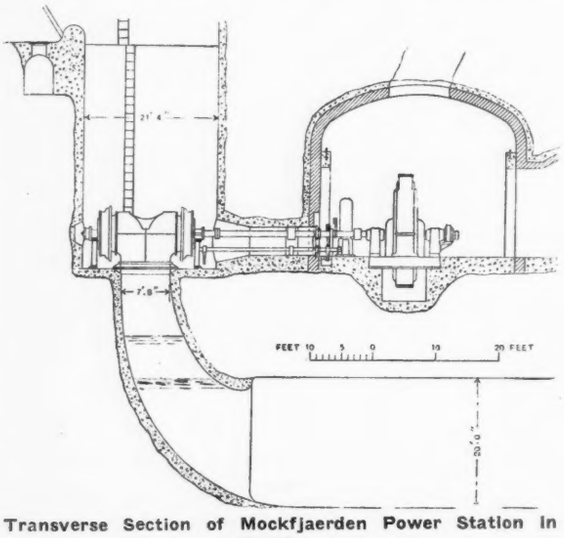
TABLE III—THE MOST NOTABLE ACHIEVEMENTS IN MAXIMUM EFFICIENCY DURING RECENT YEARS.

Plant, Year and Maker.	Head in ft.	Normal output.	Speed in r.p.m.	Max. efficiency, %.	Type.
Svalgfos Hydroelectric Station, Natodden, Norway, 1908, J. M. Voith	150	11,750	250	86.16	Double inclosed horizontal
Reinfelden Hydroelectric Plant, Switzerland, 1908, Escher, Wyss & Co.	15	1,200	68	87	Quadruple open vertical
Hamilton Cataract Co., Ltd., Canada, 1909, J. M. Voith	261	7,000	286	86.8	Double spiral horizontal
Trollhättan Hydroelectric Plant, Sweden, 1910, Nydqvist & Holm	100	12,500	187.5	87	Double inclosed horizontal
Kanderwerk Hydroelectric Plant, Switzerland, 1908, Escher, Wyss & Co.	205	3,200	400	87.4	Single spiral horizontal
Chippis Hydroelectric Plant, Rhone, Switzerland, 1911, Piccard, Pictet & Cie.	248	6,500	333	90	Double spiral horizontal
Appalachian Power Co., U. S. A., 1913, I. P. Morris	49	6,000	116	93.7	Single open vertical
Pennsylvania Water Power Co., U. S. A., 1914, I. P. Morris	63	16,500	94	93	Single open vertical
Porjus Hydroelectric Plant, Sweden, 1915, Nydqvist & Holm.	162	14,000	250	92	Double inclosed horizontal
Massaboden Plant, Switzerland, 1915, Piccard, Pictet & Cie.	142	3,500	500	90	Double spiral horizontal
Great Northern Paper Co., Millinocket, U. S. A., 1917, I. P. Morris	108	5,250	240	92	Double spiral horizontal
Forsse Hydroelectric Plant, Sweden, 1918, Verkstaden	57	3,750	250	94	Double inclosed horizontal

tidal water; hence there is a frequent variation of fall which had to be taken into consideration when designing the turbine plant. As the load can be kept practically constant, the turbines are not equipped with automatic governors but are operated entirely by hand and work with full gate opening as far as permissible, while the speed varies according to the fall available. This arrangement secures the maximum output under the prevailing conditions.

The hydroelectric power station at Forshulten, Sweden, was quoted as a typical plant of the horizontal low-pressure turbine type. It has six units arranged with double runners on horizontal shafts with an output of 3000 hp. each running at 187 r.p.m. under a net fall of 42.6 ft.

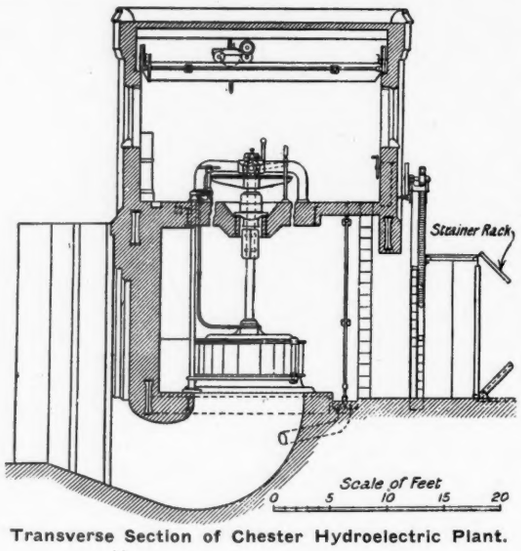
More than usual interest is presented by the arrangement adopted at the Mockfjaerden hydroelectric power station in Sweden, on account of the power house being situated underground and using open turbines under the relatively high fall of 72 ft. The arrangement of the plant is shown in an accompanying diagram. There are four units, each having an output of 5000 hp. at 225 r.p.m. with double runners on horizontal shafts. Each turbine is placed at the bottom of a concrete-lined shaft and discharges into the common tailrace tunnel. The power house is blasted out of solid rock, the floor level being approximately 70 ft. below the surface, whereas the switchboard and transformers are housed in a separate building on the ground level and communicate with the power house below through an inclined shaft. The alternators are directly connected to the turbine shafts and, due to the underground situation, special arrangements had to be made to insure sufficient cooling. For this purpose the alternators are totally inclosed and cold air is forced down a separate shaft and distributed through underground ducts



Transverse Section of Mockfjaerden Power Station in Sweden.

to each alternator, the hot air escaping from the top of the housing and being expelled through the vertical shaft communicating with the surface.

The Trollhättan hydroelectric power station, Sweden, was mentioned as a typical medium-pressure installation with horizontal shaft, and the plant at Porjus power station, Sweden, as a unique installation in the same class. The Porjus plant is also situated underground, but the turbines are inclosed in steel casings and placed at the bottom of the intake shafts about 160 ft. below ground level. The vertical shafts are cut through solid rock and provided with liners of



Transverse Section of Chester Hydroelectric Plant.

steel pipes with an internal diameter of 11 ft. 6 in. and with flanged connection to the turbine casing. There are five units with an average capacity of 12,500 hp. each under a net fall of 163 ft. running at 225 r.p.m. The turbines are of the double type with two runners discharging into the common suction casing. The power house is also blasted out of solid rock and is 36 ft. wide and 310 ft. long communicating with the turbine chambers through the short tunnels which accommodate the shaft extensions connecting turbines and alternators. The roof is supported on a strong concrete arch, and by the provision of false walls and roofs leaving a space between the rock and the walls through which warm exhaust air from the generator is allowed to pass, all dampness is prevented from penetrating into the power house. The generators have a normal output of 11,000 kv-a. and 10,000 to 11,000 volts three-phase current. The necessary switchgear and transformers are placed in a separate building on the ground level, a shaft providing communication between this building and the power house below, through which the heavy parts of the machinery can be lowered, in addition to which there are elevators both for passengers and freight. The line voltage is 80,000, the power being utilized for railway traction and for mining purposes.

In later sections of his paper Mr. Bergstrom reviewed high-pressure Francis turbines, also the subject of speed regulation, Pelton wheels, pipe lines, etc.

Summary of Principal Technical Developments.

The outstanding features of the developments described were summarized by the author thus:

(1) The exclusive use of two types of turbines only, namely, Francis reaction turbines for low and medium heads, and Pelton impulse wheels for high heads.

(2) Extension of the use of Francis turbines under heads approaching 800 ft. and Pelton wheels in single stage up to 5500 ft.

(3) Exclusive adoption of balanced wicket gates for regulation of Francis turbines and the circular nozzle with combined deflector and needle regulation for Pelton wheels.

(4) Standardization of turbine runners and increased specific speed, permitting the use of single vertical units of large outputs under low heads.

(5) General increase of output per unit, the maximum output at present being 31,200 b.hp.

(6) General increase of the over-all efficiency by about 6 to 10%.

(7) Exclusive use of oil-pressure governors.

(8) Efficient regulation (by means of differential surge tanks) of turbines using long pipe lines.

(9) Employment of large-diameter pipe lines under high heads, resulting in an appreciable reduction of the initial cost of development.

These developments, said the author, coupled with the improved construction of impounding dams in addition to multifarious improvements in details to insure effective safeguards and reliability in operation, constitute an enormous advance from a technical point of view, but of even greater significance has been the unlimited field thereby opened up for the application of electricity and the extended scope given to the utilization of water power in the service of civilization. Issues of the greatest magnitude have been raised affecting the economic life and future prosperity of nations, and from being a question to be left solely to private enterprise, the control and development of water power now rank among the vital problems of national interest.

PRIME MOVERS' COMMITTEE DISCUSSES OPERATING PROBLEMS.

At the recent meeting of the Prime Movers' Committee, N. E. L. A., the question was raised as to how frequently and how completely a steam turbine ought to be overhauled that it might be depended upon to operate for a reasonable length of time. The opinion was expressed that once a year was not sufficient for a thorough overhauling and inspection.

It seemed to be the consensus of opinion that rubbing and tripping devices be left off turbines, as they frequently shut down a unit for no proper reason. It was reported that on some turbines on the Detroit Edison Co.'s system, automatic tripping and rubbing devices had been disconnected from the throttle and were used for indicating purposes only. As to whether it is desirable to install indicators to show when a generator of a turbo unit is on fire, the weight of opinion was that such an indicator hardly seems necessary.

The matter of segregating one or more boilers (according to the size of the station, of course) to be used as water purifiers for the make-up water is now being investigated. Another matter now being given attention is that of investigating the thickness of and materials used recently for boiler settings. Other matters under way are those dealing with fuel-oil storage conditions, colloidal fuel, pulverized fuel and the recovery of coke from ash-pit refuse by the Elmore jig.

BRITISH REPORT ON FIXATION OF NITROGEN.

A report was issued in London in January by the Nitrogen Products Committee in which various measures are advanced for safeguarding the rapidly increasing demands for such products in the United Kingdom. It is recommended that the calcium cyanamide process should be established in Great Britain without delay, either by private enterprise (supported, if necessary, by the government) or as a public work. The scale of manufacture should be sufficient to give an output of about 60,000 tons of cyanamide per annum, equivalent on the basis of combined nitrogen to about one-eighth of the present home production of ammonium sulphate. The necessary electrical energy should be obtained either from water power in Scotland or from a large steam-power station.

There are several sites in Scotland where the necessary water power can be developed at a reasonable cost. If steam power is used, a suitable site for the cyanamide factory might be obtained at one of the capital power stations proposed by the Board of Trade Committee on Electric Power Supply. The costs given are based upon that expectation.

On the basis of pre-war prices plus 50%, the approximate capital outlay at a water power site would be $8,400,000, inclusive of the capital cost of the hydroelectric development, the latter being taken at $200 per hp.. ($268 per kw.) of maximum demand. If the factory were erected at the site of a large steam-power station, the approximate outlay would be $4,000,000, inclusive of the proportionate cost of the power plant. The chemical sections for either site would cost about $2,225,000 of the above totals.

As the result of the action taken upon the committee's interim recommendations, considerable progress was made with the plans and specifications for a suitable steam-power station designed as the nucleus of a possible capital power station. The committee suggests that it might prove desirable, in the first instance, to arrange for a certain proportion of the calcium carbide produced as an intermediate product to be utilized as such instead of converting it into cyanamide.

RADIO ENGINEERS HEAR ADDRESS ON REGULATION PROBLEMS.

John V. L. Hogan, manager of the International Radio Telegraph Co., was the principal speaker at the last meeting of the Institute of Radio Engineers, held at the Engineering Societies building, New York City, Wednesday, March 3. His subject was "Problems of Radio Regulation," in which Mr. Hogan discussed the gains to be secured by proper supervision, the undesirability of certain forms of legislation on radio matters and the technical aspects of radio communication which bear upon regulation by the government.

EDITORIAL COMMENT

Edison Arch on the Lincoln Highway

In arranging to place an arch over the Lincoln Highway at Menlo Park, N. J., as a tribute to Thomas Alva Edison, the Edison Pioneers have inaugurated a movement that will probably make them pioneers of another sort for, as far as known, the Edison Pioneers are the originators of this idea of adding decorative features to the cross-continent highway. Its route, stretching as it does from coast to coast, passes through many historic spots, and arches commemorating the different events or features that made the particular spot in the highway of interest could be marked in no better way than by an arch spanning the highway as will be the case of the Edison arch at Menlo Park. It is a subject that should be of interest to all civic and social organizations in states, counties and cities that the Lincoln Highway passes through.

Transmission Towers

With the coming of super-power zones, transmission trunk lines and interconnected distribution systems comes also a growing importance of the supporting structures and insulators which will carry these lines; also of the switching and transforming apparatus that will make these wholesale purveyors of electrical energy safe and practical from an operating standpoint. Present engineering practice and design has kept pace with such projects; in fact, it is because of the advances made that such projects are at all possible.

Many years will not pass before the industrial and well-populated districts of this country are thoroughly blanketed with a network of high-tension trunk lines for distributing electrical energy. Built for the ultimate economic good of the public, they must also be built with due regard for the safety of the public and for the dangers attendant upon overhead transmission lines as well as with proper regard for the economics of such construction and the practicability of operation.

Consideration of these important questions is given in a series of articles on the subject of steel transmission towers by Mr. E. F. Gemmill, who has prepared a summary of present engineering practice relating to the design and installation of transmission towers, together with much original data he has gathered on the subject. The first of these articles, which appears on other pages of this issue, deals with the forms of steel towers and with the effect of loading upon their design. Subsequent articles will take up theory and practice regarding suspension spans, sag calculations, spacing of conductors and towers, and the design and erection of towers.

Progress in electrical construction, outside plant as well as inside plant, is being made rapidly, and transmission line engineers who are keeping up with present practice, or, rather, a step ahead, will undoubtedly find Mr. Gemmill's articles valuable contributions to the literature on the subject of transmission towers.

Value of Commercial Research

A marked characteristic of our age is its recognition of the value of research. Research received its first trial at the hands of the searchers for nature's fundamental laws. The development of inductive philosophy and systematic experimentation led to the gradual growth of research in pure science. Its steady acceleration was responsible for the extraordinary impetus in all scientific development in the last century.

As the scientists with increasing energy revealed nature's laws and facts, the useful application of this knowledge gained headway. At first the industries applied science in isolated instances and in a haphazard manner. Gradually, however, it was realized that the results of research in pure science quite generally required further research to secure their most effective utilization. From this has grown a distinct branch of investigation known as industrial research. In the last few decades many large manufacturing corporations have established research departments with splendidly equipped laboratories and the electrical industry boasts several of these that are most noted. Such industrial research organizations have amply repaid their expense by the development of new and improved products, new and better processes for their production, and often of new uses for products already developed. Manufacturing companies are not alone in establishing industrial research laboratories; many colleges and governmental departments have created similar institutions, often under the name experiment station. The value of such industrial research cannot readily be estimated, but it is extremely high and is now very generally recognized as such. In

agriculture alone it has enriched our country to the extent of many billions of dollars, and in all industries where it has been applied it has yielded a greater variety and volume of products for the markets and helped to reduce their cost.

Research has thus given us scientific production. But between production of commodities and their final use by the consumer is the realm of the distribution agencies. In relatively few instances does the consumer purchase direct from the producer; both convenience and economy require the products to be distributed through established commercial channels. Yet in most cases in the selling price a considerable percentage represents selling expense and in not a few commodities the distribution costs and profits form a larger part of the final selling price than the cost of production and profit of the producer. This fact has given rise to a host of economic theories that aim to eliminate or at least reduce the distribution costs.

Commercial research, that is, systematical and critical investigation of marketing conditions and methods as contrasted from industrial research or investigation of production, has already been introduced in recent years with excellent results. One of its aims is to make a scientific study of the prevailing market for a particular product or line of products to find out as nearly as possible the exact origin, magnitude and other characteristics of the demand, how it is being met and by whom, the possibilities for increasing the demand or at least the satisfaction of the purchaser, and other pertinent facts on the existing and potential market. With an array of such facts, carefully compiled and analyzed in an unbiased manner, the sales manager can direct the efforts of his sales organization intelligently and along the most effective lines so as to produce the maximum sales for a particular selling outlay or, in other words, to reduce the unit selling cost to a minimum.

At the present time sales policies and methods are left very largely to the judgment of the sales manager. If his judgment is based on facts and not merely on theories, his organization is much more likely to achieve valuable results. In but few instances, such as where the market is a very restricted one, can an individual secure a comprehensive summary of the necessary facts through personal experience. A disinterested outside organization with special training and facilities for conducting such commercial research can generally ascertain the desired information better than members of the sales staff itself. An excellent example of the work of such a special organization was shown in the survey of industrial lighting conditions summarized in recent issues of the ELECTRICAL REVIEW. We believe the electrical industry is especially in need of such systematic studies of its markets. Our industry is at the threshold of a wide expansion of its commercial development. It will achieve the best results from that development by a scientific study of existing and prospective markets, by a judicious application of commercial research.

The Skip-Stop Plan

Of the many policies and practices that came with the war as being necessary to winning the war, many are gone. Sacrifices were necessary, personal privileges had to be relinquished, and restrictions and curtailments had to be practiced. Under the stress of war, the nation gladly accepted these things. But with the coming of peace, one by one these restrictions and forced economies have been dropped or at least allowed to be matters of individual inclination. In the interests of democracy this is well. In other ways it is objectionable, for economy suffers.

Fuel saving became a fact, with promise of even greater conservation, under the rulings and mandatory regulations of the Fuel Administration. But for fuel saving to become permanent and the education of the people to bear full fruit, the war ended too soon. Slowly the wastes of fuel are reoccurring; that they have not yet assumed the magnitude they did before the war is chiefly because coal is so high priced.

One of the good things that came out of the war in the way of economy is the skip-stop. The skip-stop was advocated by the Fuel Administration as a fuel-saving measure. The saving in fuel is, actually, rather small—about 1%. But it helps—and every needless waste is an extravagance. While some electric railway utilities have gone back to their previous mode of operation, many more have found the skip-stop so advantageous to themselves and so well liked by their patrons that they are retaining it.

The skip-stop, which means reducing the number of stops per mile, has speeded up schedules, saved wear and tear of equipment, lessened the delays and accidents due to taking on and off of passengers, lowered the energy consumption and maximum demand. It is generally conceded that more power is consumed by the rheostats in starting up cars than is actually used by the motors for running. Eliminating every needless stop thus immediately adds to the over-all efficiency and lowers power consumption. It is not continuous running but the frequent starts under load that cause motor burnouts. It is the frequent stops that wear out wheels and brake-shoes, consume air and add generally to the cost of operation. The skip-stop reduces all these and while doing so betters service.

CURRENT EVENTS

Reports of Important Meetings, Developments and Other Happenings of the Electrical Industry and Its Allied Interests

WESTERN ENGINEERS PAY TRIBUTE TO HERBERT HOOVER.

Is Given Washington Award for Conspicuous Service in World War at Dinner Tendered Him in Chicago on Feb. 28.

Although Herbert C. Hoover, "the man who fed the world during the war," did not reach the banquet in his honor given by the Western Society of Engineers in Chicago on Feb. 28 until nearly midnight, owing to being delayed by a train wreck, the 1500 guests present waited for him and heartily greeted Hoover on his belated arrival, after which he was given the Washington Award for conspicuous service as federal food administrator and director of European relief.

Despite the lateness of Mr. Hoover's arrival, he made a speech in which he discussed the inter-relationship of general industry and food production and distribution. "There are not only engineering problems involved in this relationship," said Mr. Hoover, "but there are great social and political issues of the first importance." He pointed out that the farmer's main production must find its market either in the great industrial centers along the Atlantic seaboard or in export to Europe. He also said the American farmer receives a less proportion of the consumer's purchase price for his product than the farmer of most civilized countries. The American margin between the farmer and the consumer is the widest in the world, he said. "A partial remedy for this situation is advanced many times by our engineers," said Mr. Hoover. "This is the possible help from improving the waterways from the Great Lakes to the Atlantic seaboard by way of the St. Lawrence so as to pass full seagoing cargoes. The result would be to place every port on the Great Lakes on the seas. Fifteen states contiguous to the lakes could find an outlet for a portion of their annual surplus quickly and more cheaply to the overseas market."

A. I. E. E. WILL HOLD MEETING IN PITTSBURGH, MARCH 12.

Session Will Be Joint One Under Auspices of Pittsburgh Section and Traction and Transportation Committee.

On Friday, March 12, the American Institute of Electrical Engineers will hold its 358th meeting in Pittsburgh under the joint auspices of the Pittsburgh Section and the Traction and Transportation Committee. Headquarters for the meeting will be at the William Penn hotel. During the morning there will be an inspection trip through the Westinghouse Electric & Manufacturing Co. plant, concluding with a luncheon to the engineers by the company. Technical sessions will be held in the afternoon and evening, broken up by a subscription dinner at 6:15 p. m.

The following subjects will be discussed at the technical sessions: "Short-Circuit Protection for D-C. Substations," by J. J. Linebaugh, General Electric Co.; "Flashing of 60-Cycle Synchronous Converters and Some Suggested Remedies," by Marvin W. Smith, Westinghouse Electric & Manufacturing Co.; "Automatic Railway Substations," by Frank W. Smith, General Electric Co.; "Automatic Substations for Heavy City Service," by R. J. Wensley, Westinghouse Electric & Manufacturing Co., and "The Two Designs for the Chicago, Milwaukee & St. Paul Locomotives," by W. O. Batchelder, General Electric Co., and N. W. Storer, Westinghouse Electric & Manufacturing Co.

EDISON PIONEERS ENLARGE SCOPE OF ORGANIZATION.

Amend Constitution to Provide for Taking In Employes Working for Edison Companies Between Period of 1886 and 1900.

At the annual meeting of the Edison Pioneers, held at the Edison laboratories in West Orange, N. J., in connection with the dinner tendered Thomas A. Edison by the Pioneers on Feb. 11 last, the occasion being the seventy-third birthday of Mr. Edison, some important changes were made in the constitution and by-laws of the organization.

The principal change has to do with the qualifications for membership, which up to this time has been confined to those associated with Mr. Edison in his various interests from 1870 to 1886. The by-laws have now been changed to allow all persons connected with the Edison interests between 1886 and 1900 to come into the Pioneer organization as associate members. Those whose service dates prior to 1886 will be known as "founder members," and on the death of a member his descendants will be eligible for membership. Associate members will have all the rights of "founder members" except that the membership dies with the holders and does not descend to the family. It is estimated that fully a million people were connected with Mr. Edison's various activities in this country during the 1870-1900 period and the Pioneer organization gives promise of becoming a large one.

Past President Francis R. Upton of the Pioneers, who assisted in the development of the incandescent electric lamp, and one of the ablest associates in all of the work at the Menlo Park (N. J.) laboratory and elsewhere, notably as general manager for many years of the Edison Lamp Co., made an announcement regarding the memorial arch in Mr. Edison's honor that is to be erected by the Pioneers at Menlo Park,

N. J., over the Lincoln Highway, which passes Mr. Edison's old home and the site of his old laboratory at that point.

It is expected that the cornerstone of the arch will be laid during this year with appropriate ceremonies, and later stone posts with tablets will be erected to mark the exact positions of the various buildings at the Menlo Park plant.

At the dinner tendered Mr. Edison on his birthday more than 50 members of the Pioneers were present, the only others present beside Mr. Edison being Mrs. Edison, Mr. and Mrs. Charles Edison, Mr. and Mrs. John Sloan (Mrs. Sloan being a daughter of Mr. Edison) and Thomas A. Edison, Jr. The dinner was held on the top floor of the Edison storage battery building and the big room was tastefully decorated with electric lights, Mr. Edison's name and a huge "73" in flashing colors being the centerpiece of the decorations, the "73" being the telegraphic code signal for "greetings."

Preceding the dinner the annual business meeting and election of the Pioneers was held. Retiring President John W. Lieb read his annual address in which he outlined the activities of the Pioneers during 1919. The following officers were elected: President, Major William J. Hammer; vice-presidents, Alfred W. Kiddle, Samuel Insull, Charles L. Edgar, Sidney B. Paine; executive committee, Francis R. Upton, John W. Lieb, Dr. Edward G. Acheson; secretary, Robert T. Lozier; treasurer, Frederick A. Scheffler, and historian, William H. Meadowcraft.

During the meeting it was announced that the following members of the Pioneers had died during 1919: Phillip S. Dyer, W. J. Jenks, Alex. T. Moore, Frederick Sargent and F. S. Smithers.

MEETING OF MATERIAL HANDLING MACHINERY MANUFACTURERS.

Association Holds Important Convention in New York to Discuss Problems Relating to Efficient Port and Terminal Equipment.

That there is a tremendous opportunity for American industry to reduce the cost of production was shown by the papers and discussions presented at the annual meeting of the Material Handling Machinery Manufacturers' Association, held in New York City, Feb. 26-27. The opportunity is presented in all branches of industry. It exists in ports and terminals, in freight depots, in manufacturing plants, in central stations, and in every industry in which the movement of material is necessary. Private manufacturers already see the advantage of installing handling machinery for the movement of raw material, of material in the process of manufacture and of finished products. The railroads and marine shipping organizations are beginning to see the desirability of replacing man power by machinery in the loading and unloading of freight.

FIELD FOR MATERIAL-HANDLING EQUIPMENT.

The morning session on Feb. 26 was devoted principally to conducting the business of the association, following which Calvin Tompkins, in his presidential address, suggested several fields that are open to development in addition to those with which the association has been concerned. These fields are railway terminals, marine terminals and private factories. In the latter institutions some material-handling equipment has been installed, but the development has scarcely begun. Motor trucks are capable of expediting the horizontal movement of material and elevators are capable of expediting the vertical movement. But these two machines have not yet been made to work together on a large scale. This situation exists because potential users of this kind of equipment are not aware of the advantages that will accrue when these two utilities are combined for the movement of material.

R. W. Scott stated that he was alarmed over the present condition of our foreign trade. Foreign trade did not concern American manufacturers before the war because such trade did not exist. The war gave American manufacturers an opportunity to sell their product abroad and developed a demand for American made goods that could not have been developed as readily by other means. This trade, which now is a valuable asset, is in a precarious condition, the reason for which is that the cost of production in this country is so large that American manufacturers will be unable to compete with foreigners when conditions become stabilized. Some method must be adopted that will reduce the cost of production, and the best available is to replace man power by machinery. American manufacturers cannot compete with foreigners for foreign trade so long as the present loss of $20 per ton for trans-shipment is sustained in the port of New York. Mr. Scott suggested that the association could render service to American manufacturers by impressing upon their minds the precarious condition of foreign trade.

Calvin Tompkins explained the reasons why the cost of handling material in the port of New York is so large. One is that the railroads have not provided proper terminal facilities. They are not interested in improved terminal equipment, because installation of that equipment means considerable expense to them. As long as they get paid for the transportation of freight they are satisfied. They make no effort to disclose the enormous cost of handling freight in New York Harbor; in fact, they are inclined to keep such information secret.

Zenas W. Carter, secretary of the association, outlined some of the activities during the past year. He mentioned the fact that the National Electric Light Association is interested in the movement of installing material-handling equipment, and that the New York Edison Co. already has begun the promotion of the idea. The association has been instrumental in getting courses in transportation included in the curricula of several universities, with 155 of which the association is in direct contact.

F. R. Fishback said that the railroads are the organizations to which the association should devote most attention. His reason was that these are the organizations from which the private manufacturer of freight-handling machinery receives least attention.

F. W. Hall suggested that the association enter upon a campaign of advertising. Already there is a subconscious idea of the value of

handling machinery in the minds of men in control of industries. This idea can be capitalized by an advertising campaign that will present in brief and concise form the advantage of using material-handling equipment. Such a campaign, moreover, would show potential users not only the various applications of this equipment, but would in addition show them where they can get the equipment. At present the idea is so new that potential users do not know where to go to get handling machinery suitable to their needs nor to get information about such machinery.

Motorized Terminal at Cincinnati.

At the Thursday afternoon session, B. F. Fitch, president, Motor Terminals Co., read a paper describing the new motorized terminal at Cincinnati. Before adopting motor trucks, that terminal was one of the most severely congested in this country; now it is one of the most expeditious. The scheme used is entirely new. It consists in building several closed bodies for motor trucks that are 8 by 8 by 17.5 ft. in dimension. These bodies are dismountable and provided with hooks so that they can be lifted by overhead equipment. The bodies are made of angle-iron frames and board siding, and have both end and side doors. A motor car loaded with incoming freight backs into a warehouse and the inclosed body is lifted up and set on the floor of the warehouse. While that body is being filled the truck is loaded with a body already filled and proceeds to its point of destination. This scheme is used for freight originating in Cincinnati, or delivered to Cincinnati, or transferred from one railroad to another.

The system operates more satisfactorily than it was expected to operate, and has reduced the cost of terminal transfer of freight more than was anticipated. It saves a vast amount of switching of cars and eliminates a large amount of terminal facilities that would be necessary for transferring freight from one railway car to another. In the three years of its operation the management of the system has not had one claim for damages. The scheme is applicable to any terminal because of its elasticity and because no new arrangement of terminal facilities is required. It is estimated that a similar terminal in New York City would save $3 per ton on all freight entering or leaving that port by rail.

Capt. F. T. Chambers, U. S. Navy, described freight-handling equipment in England, and made some remarks about the advisability of applying English methods to marine terminals in this country. Captain Chambers obtained his information about British port equipment first hand while making an investigation of that subject for the Shipping Board. He stated that the idea in the United States seems to prevail that new piers should be built like old ones. This is wrong. The piers must be built to accommodate new and larger ships and to expedite the movement of freight. This means that there must be provision for freight-handling equipment, for storage space, for aisles and for railroad tracks. Wider piers in this country are necessary.

The British piers are well equipped with machinery for unloading and loading ships, and a large part of that equipment is electrically operated. Railway tracks are 15 ft. between center lines. In flour mills and cold-storage warehouses some modern transportation equipment is installed. This equipment consists of belt conveyors in flour mills, overhead conveyors for carrying beef in refrigerators, etc. Bunkering in Britain is usually done by hand, but there are some mechanical loaders. At some terminals coal is loaded on ships by machines that pick up the cars and dump the coal directly into the ships. In general, he said, Americans have little to learn from Britains in the way of handling freight at ports. This is true because the conditions in Britain are not the same as the conditions in this country.

Advertising Material-Handling Idea.

The Friday morning session was devoted to a consideration of methods of advertising both the material-handling idea and equipment. Papers were read by A. J. Barnes on potential demand for material-handling machinery, by F. R. Davis on the need for an encyclopedia correlating material handling machinery, by Anderson Pace on the application of motion pictures to sales, by A. F. N. Thomas on direct publicity by association publications, by P. C. Gunion on the value of association advertising, and by Roy Dickinson on organized industrial co-operation.

Mr. Barnes presented the results from a questionnaire sent out in an effort to make a survey of the material-handling field. From this survey it was observed that the users are not generally familiar with material-handling equipment. It was learned that 5% of the industrial plants used labor-saving machinery, but 95% do not. Those familiar with material-handling equipment comprised 35%, while nearly 50% knew nothing about the producers of labor-saving devices.

F. R. Davis presented a proposal to have the association give its support to an encyclopedia of material-handling machinery, this to include definitions of terms in use, technical articles on the use and performance of the machinery, advertisements and other data. Plans have been made to undertake the publication of the encyclopedia, which is to be an annual.

Anderson Pace, who has had considerable experience in sales promotion work by means of motion pictures, gave some of his own observations on the work.

A. F. N. Thomas suggested the publication of a periodical by the association as a means of obtaining direct publicity. P. C. Gunion stated that paid publicity is what pays dividends. The association has an idea that should be imparted because the idea is based on the economic truth that machinery handling is cheaper than manpower.

The substance of Mr. Dickinson's paper was that the association had a wonderful opportunity to promote industrial peace between capital and labor, since most of the members of the association are engaged in production.

Henry W. Standart read a paper at the afternoon session on the advantages of association work and methods of attacking large problems by joint action. He showed that if the material-handling idea is to be disseminated properly it must be done by co-operative activity.

A. R. Ulbrich, who spoke on the material-handling problem, in regard to the buyer, sales-

man and the association, emphasized what Mr. Standart had said, and in addition urged that salesmen be more thoroughly educated in the freight-handling problem than they are at present. He suggested that the association devise a scheme whereby salesmen of the members could be schooled at certain intervals in the science of transportation and material handling.

The paper by A. R. Smith, editor of *Marine News,* presented a brief description of the condition of the port of New York. He showed that there is considerable mechanical equipment on the piers and in the terminal warehouses in the New York Harbor, but that the material is generally of small size and in single units rather than in batteries. He estimated that 150,000,000 tons of freight are handled in the New York port annually. If the cost of handling is reduced 50%, as it may possibly be, an enormous saving will result.

A paper by George V. Green described the pier of the East Waterway Dock & Warehouse Co. at Seattle. This pier is part of the largest private terminal in the United States, and the largest vegetable oil terminal in the world. The piers are equipped with handling machinery and with railway tracks, and 50% of the freight is handled directly between cars and ships. By the installation of this machinery man power has been reduced in the ratio of 50 to 17.

At the afternoon session the association adopted a resolution urging Congress to appropriate the sum of $1,900,000, as originally applied for, to the Bureau of Foreign and Domestic Commerce for service to industry.

The board of governors of the association for the present year will include as holdover members, Lucien C. Brown, L. L. Parker Co.; J. C. Walter, Alvey-Ferguson Co.; Fred Stadelman, Wellman-Seaver-Morgan Co.; F. W. Hall, Sprague Electric Works, and R. W. Scott, Otis Elevator Co. The new members of the board will be Henry W. Standart, Northern Engineering Works; W. F. Merrill, Lamson Co.; Donald V. Jenkins, Watson Elevator Co.; Roy Owens, Lakewood Engineering Co.; T. Robins, Robins Conveyor Belt Co.; C. W. Miller, Jeffrey Manufacturing Co., and G. O. Helmstaedter, Hyatt Roller Bearing Co.

Features of the formal luncheon on Thursday were addresses by Arthur E. Harrell of the New York *Tribune* on "Americanism and Business," and by John F. Wahl of Petrograd and Copenhagen on the "Resources and Possibilities of Russia."

N. E. L. A. ADDS TO SERVICE AND PUBLICITY DEPARTMENTS.

Fred W. Herbert and George F. Oxley Appointed as Part of Plan to Increase and Better Service to Member Companies.

In line with plans made by President R. H. Ballard, Executive Manager M. H. Aylsworth and members of the executive committee of the National Electric Light Association for increasing and bettering the service rendered to member companies comes the announcement from association headquarters in New York City that Fred W. Herbert has been appointed superintendent of the service department and George F. Oxley director of the publicity department.

Mr. Herbert formerly was chief statistician for the Colorado Public Utilities Commission and is a trained accountant, a practical rate man and has been closely associated with state regulation, accounting and statistical work. Prior to his appointment as chief statistician of the Colorado Public Utilities Commission five years ago, he was connected with western utilities for many years as secretary and auditor. While affiliated with the Colorado Public Utilities Commission Mr. Herbert drafted the uniform classification of accounts now in force for all public utilities in Colorado, which has been copied, in whole or in part, by many other state utilities commissions. Among other matters he will assist in promulgating and interpreting the uniform classification of accounts established by the National Electric Light Association for all electric utilities, and have charge of rate research and general statistical service for member companies of the association.

Mr. Oxley's work, as director of publicity, will supplement that of the National Committee on Public Information and the Advertising and Publicity Service Bureau, and will comprise supervision of the National Association *Bulletin,* the promulgation of a plan of national publicity in the interests of the electrical industry, and the organization of public information work throughout the country. Mr. Oxley received his newspaper training on Worcester, Mass., and Boston newspapers, and in later years has been special writer, city editor and political and editorial writer on newspapers in the West. For two years he was secretary of a utilities commission in the West, resigning just prior to the entrance of the United States into the World War to become a national organizer for the American Red Cross and subsequently becoming associate manager and then manager of the Mountain Division of the American Red Cross, resigning the latter position to again enter commercial life.

RESULTS OF TESTS ON RADIO TELEPHONE INTERESTING.

New York Electrical Society Hears Addresses on Long-Distance Radio Telephone Transmission and Engineering Phases of Industrial Unrest.

An unusual program was presented by the New York Electrical Society at its 380th meeting on Feb. 26. It included a paper on long-distance radio telephone tests by Robert F. Gowen, engineer for the De Forest Radio Telephone & Telegraph Co., and an address by Dr. Charles A. Eaton on the engineering side of the great industrial unrest.

In his talk Mr. Gowen outlined the results of tests conducted from a wireless station installed in his residence at Ossining, N. Y., these tests being made for the purpose of comparing damped and undamped wave systems. He said that at first he was able to speak with West Point, N. Y., and then, after rearranging his apparatus, he was able to get Utica, N. Y. Later he was able to converse with Columbia City, Mass., and his speech was reported to be four times as loud at

the telephone receiver as the ordinary speech. A little later he talked with Little Rock, Ark., 1200 miles away; with Chicago; with St. Paul, Minn.; Topeka, Kan., and other distant stations.

Because of the very large number of amateur stations in this coutnry, Mr. Gowen found it necessary to perform his experiments after midnight. He said that the confusion caused by the large number of messages received at his station previous to midnight made it impossible for him to work during that time. This confusion arises from the fact that most of the 300 amateur stations in this country do their talking in the late evening. One of the peculiar conditions that Mr. Gowen observed was that he was unable to speak with nearby stations, including New York City. His data indicates that the undamped wave does not fade, but that the peculiar phenomenon by which the message appears to die out is merely a swinging effect that is temporary.

Dr. Eaton, who since the beginning of the war has been investigating industrial conditions in this country and the allied countries, presented the results of his investigations. The essence of his remarks was that the American people have become inoculated with a germ of distrust of each other that makes itself apparent in all of their activities. This distrust is the principal impediment to normal production. The employer is distrustful of the man he employs and the employe is distrustful of the man who employs him. Increased production is the only thing that will prevent an economic disturbance in this country, but that production cannot become effective until this wave of distrust is eliminated.

OPEN HEARINGS ON DEEPENING OF ST. LAWRENCE RIVER.

New York State, City of Montreal and Eastern Railroads Voice Vigorous Opposition to Plan and Stand Behind Use of Erie Canal.

The International Waterways Commission began hearings on the project of enlarging the ship channel in the St. Lawrence river from Lake Ontario to Montreal at the joint expense of the United States and the Canadian governments in sessions at Buffalo, N. Y., on March 1.

The proponents of the plan include fourteen northwestern states, the prairie provinces of Canada, northwestern cities and ports, and shipping interests on the Great Lakes. Their chief arguments are lower freight rates to tidewater and increased electrical power from the improved channel.

Opposed to them are the state of New York, Montreal, eastern railroads of the United States and cities located along the Erie canal. The opposition has organized and selected former State Senator Henry W. Hill as their spokesman.

Mr. Hill said the opposition expected to show that it would be unwise for the United States to spend the large amount of money involved on a "problematic enterprise outside the confines of this country when so many projects within are crying for attention."

State Engineer Frank M. Williams, the first spokesman, vigorously opposed the project as unfair to the state and declared it was an idea of theorists and not the well thought out plan of practical vessel men.

Henry C. Barlow of Chicago, member of a large delegation from the Middle West, said the Mississippi valley was looking for an outlet to the sea. In championing the cause of a ship canal to tidewater by way of St. Lawrence, he declared the west was not against the development of the Erie canal.

"We are in favor of it," he declared. "The next generation will need all the waterways possible to handle the developing commerce and industry of America. Development of Canada will help America just as development of the United States has helped Canada."

BELL TELEPHONE SYSTEM MAKES ANNUAL REPORT.

Company Passes Through War Period in Healthy Condition to Undertake Post-War Responsibilities.

That the Bell System has passed through the strenuous period of war conditions with its plant, management and finances intact and is in a healthy condition to undertake its post-war responsibilties with a minimum of delay, is clearly shown by the annual report of the American Telephone & Telegraph Co.

H. B. Thayer, president of the company, gives an interesting history of the details and results of the year's operation not only of the American Telephone & Telegraph Co. but of the whole Bell System. The report not only shows the component parts of the Bell System and their relationship to one another, but it describes how the system functions in order that each of the associated companies should get the greatest value from the headquarters organization with its accumulated experience and abundant resources.

As in the past, the actions of rate controlling bodies have, in general, been acceptable. There are exceptions, as always, but the tendency is toward more equitable and more sound treatment. It is becoming more clearly understood that in a utility of this sort, which in order to give service must expand with the growth of the community, the test of rates—assuming economy and efficiency—is the return which will attract capital.

"No man and no corporation," says Mr. Thayer, "had a right to expect to come through the great war untouched. Our greatest loss was the loss of these margins for plant growth and reserves of men and women in training. During the war the restriction on the use of capital and material, coupled with the unprecedented demand for service, compelled us in some places to exhaust our plant margins and left us at the beginning of 1919 with an actual shortage of plant to meet the then demands. By the end of the year, except in a few localities, the usual facilities were restored."

Among the new features which are brought out in this report are automatic switchboards which have been developed by the Bell engineers and which while more expensive in first cost

than manual boards, will do much to offset the increasing cost of giving telephone service.

The toll cable system is being extended and is expected to be completed to Chicago by 1923. In co-operation with the Cuban-American Telephone & Telegraph Co. plans have been made to lay telephone cables to Havana, so that the principal places in Cuba will be in telephone connection with the principal places in the United States.

The report shows what is being done to provide adequate telephone plant and adequate traffic supervisory forces and operators. At one time the turn-over in operators reached the rate of 80,000 a year. During the year the company has actively prosecuted work upon more than 500 improvements in the telephone art. The patent holdings of the Bell System have increased fully 12½% during the year, and it now owns or controls, or is licensed under, more than 5000 United States letters patent and applications therefor.

There were 15,000 telephone men in war service from the Bell System and practically all who have applied for reinstatement have been re-employed.

There were 209,860 employes in the Associated Bell Companies at the end of the year, who are operating 24,162,999 miles of wire, of which 94.6% was copper. The net additions to the Bell-owned plant during the year were over $73,000,000.

MEETING OF ELECTROCHEMICAL AND ELECTRICAL ENGINEERS.

Announcement is made that plans for the joint session of the American Electrochemical Society and the American Institute of Electrical Engineers at Boston, April 8, 9 and 10, are progressing so favorably that there is every promise of an unusually good meeting.

A symposium on electrically produced alloys will be opened by H. E. Howe, with a paper on "Fundamental Problems in Alloys Research." "The Manufacture of Ferro-Alloys" will be discussed in two papers by R. J. Anderson and C. B. Gibson. Other papers on special alloys will be presented, as follows: "Ferro-Vanadium," by B. D. Saklatwalla; "Ferro-Silicon," by F. A. Raven; "Nickel-Chrome," by W. B. Driver, Jr.; "Cobalt-Chrome," by Ellwood Haynes; "Ferro-Manganese," by E. S. Bardwell, and "High-Speed Steel in the Electric Furnace," by R. C. McKenna.

The session on power requirements for electrochemical industries will be addressed by H. A. Winne, C. A. Winder and John A. Seede. Other papers of technical importance will be on "Nitrogen Fixation by the Silent Electric Discharge," by C. F. Harding, and "Magnetic Properties of Iron-Nickel Alloys," by T. D. Yensen. A symposium on colloids will comprise a large number of papers.

PITTSBURGH CLUB HEARS TALK ON RAILROAD ELECTRIFICATION.

The mechanical and electrical features of the new Westinghouse electric passenger locomotives for the Chicago, Milwaukee and St. Paul railway were explained by N. W. Storer of the Westinghouse Electric & Manufacturing Co. in an illustrated talk given before the Railway Club of Pittsburgh on Feb. 26. Among other features, Mr. Storer described the twin armature motors, which are geared to a quill which are around and concentric with their respective wheel axles. The quills are connected to the wheel-flanges by means of coiled springs which eliminate the possibility of shock to the trucks.

A. I. E. E. ANNUAL CONVENTION DATE AND PLACE FIXED.

In accordance with the action of the board of directors of the American Institute of Electrical Engineers at a meeting held Feb. 18 and negotiations carried on since, it has been decided to hold the annual convention of the Institute at The Greenbrier Hotel, White Sulphur Springs, W. Va., June 20 to July 2. This is a week later than was originally planned to hold the convention. Details will be announced later.

COMING CONVENTIONS.

Wisconsin Electrical Association. Annual convention, Milwaukee, Wis., Mar. 24-25. Headquarters, Hotel Pfister.

American Electrochemical Society. Annual convention, Boston, Mass., April 7-10. Friday, April 9, joint session with American Institute of Electrical Engineers on "Electrically Produced Alloys." Secretary, Joseph W. Richards, Bethlehem, Pa.

American Association of Engineers. Annual convention, St. Louis, Mo., May 10 and 11. Headquarters, Planters Hotel. Secretary, C. E. Drayer, 63 East Adams street, Chicago.

Southwestern Electrical and Gas Association. Annual convention, Galveston, Tex., May 13-15. Headquarters, Hotel Galvez.

National Electric Light Association. Annual convention, Pasadena, Cal., May 18-21. Headquarters, Hotel Huntington. Acting secretary, S. A. Sewall, 29 W. 39th street, New York City.

American Institute of Electrical Engineers. Annual convention, White Sulphur Springs, W. Va., June 29-July 2. Headquarters, The Greenbrier. F. L. Hutchinson, secretary, 33 West 39th street, New York City.

Ohio Electric Light Association. Annual convention, Cedar Point, Ohio, July 13-16. Secretary, D. L. Gaskill, Greenville, Ohio.

Pacific Coast Section, American Institute of Electrical Engineers. Annual convention, Portland, Ore., July 21-23.

National Association of Electrical Contractors and Dealers. Annual convention, Baltimore, Md., Oct. 6. Secretary, W. H. Morton, 110 West 40th street, New York City.

ROCHESTER ENGINEERS HEAR TALK ON ALUMINUM.

Dr. Earl Blough, head of the research department of the Aluminum Company of America, was the speaker at the regular meeting of the Rochester (N. Y.) Section, American Institute of Electrical Engineers, on Feb. 27. Dr. Blough's subject was "Manufacture of Aluminum."

COMMERCIAL PRACTICE

New-Business Methods, Policies, Rates and Kindred Central-Station Matters for the Man Engaged in Selling Electricity

EARNINGS INCREASED BY USE OF SYNCHRONOUS MOTOR.

Replacement of Steam Engine by Synchronous Motor Results in Substantial Savings in New York Refrigerating Plant.

An excellent example of the economy of the synchronous motor, as compared with the steam engine, for driving ice machines is the installation in the Manhattan street dairy of the Sheffield Farms Co., New York, where 80,000 quarts of milk are handled every day.

This plant contains four 80-ton Newburg ammonia compressors and a 12-ton York compressor, which were driven by steam engines before the war. After the United States entered the war, however, fuel was scarce, its price rose rapidly and the government ordered all inefficient engine-driven ice plants to be closed down. The necessity of making some change in their drive was realized by the officials of the Sheffield Farms Co., so they decided to use an electric motor and obtain power from the local lighting company.

The present drive consists of a 500-hp. Westinghouse synchronous motor, operating on a 440-volt, 60-cycle circuit, and which has a speed of 350 r. p. m. This motor is belted to a line shaft, from which all of the compressors are driven and, in addition, two 14 by 10-in. air compressors and two generators of 110 kw. and 125 kw. capacity, respectively, used for lighting. Energy is supplied by the United Electric Light & Power Co.

While this installation, which was originally planned for engine drive, is not arranged in an ideal manner, nevertheless the officials state that the efficiency of the motor supplied with central-station power is so much greater than that of the older drive that its savings and increase in capacity amount to $30,000 a year.

One of the interesting features of the installation which is now recognized to be of great importance in ice-plant management is the careful attention given to the graphic meter chart which shows the amount of power being used. Since the load is practically constant under given conditions, the curve drawn by the meter should ordinarily be a straight line. But any variation in the factors of production, such as the depreciation of any part of the machinery, a change in the temperature of the brine water, etc., or the alteration of any other detail, at once changes the power demand, which is noted by the meter. An investigation is immediately made as to the cause of the variation and correction is applied as soon as possible. Thus the efficiency of the plant is kept at a maximum at all times.

The use of a synchronous motor instead of an induction motor for this installation is in line with the present tendency in refrigerating engineering practice. The synchronous motor is favored because of its high efficiency, uniform speed and ability to improve the power-factor of the electrical system in the plant. An ammonia compressor is well adapted to be driven by this type of motor because, with the use of by-passes, the starting conditions are light and the speed is constant.

At the Sheffield Farms plant 110 tons of ice are produced daily from purified and filtered city water.

ATTITUDE HAS IMPORTANT BEARING ON COMMERCIAL DEVELOPMENT.

Discussion and Example of How a Central-Station Company Made Substantial Success of Campaign to Sell Electric Ranges.

Much food for thought is invariably brought out in meetings for comparative reports on sales activities and promotion work. An analysis of the facts seems to develop that certain things are both possible and impossible at the same time. Each favorable or unfavorable condition is backed by almost irrefutable proof which, if taken alone, would seem to settle the situation forever.

Men of national reputation in their field, with past record and present position justifying the acceptance of their opinions as the last word on the subject, take quite opposite sides over the prospective merchandising success and possibilities of an article. Both have the same obstacles to overcome in their respective localities. One sells hundreds of washing machines or other electrical household appliances and the other presents excellent reasons showing why large sales must be looked upon as impossible. One is very optimistic and has a big sales record to justify his optimism. The other is pessimistic, and has sound reasons that appear perfectly logical to anyone having a knowledge of the business, explaining his attitude. The first is making an unqualified success doing the very things the latter authority says cannot be done.

As conditions favorable and unfavorable are about the same in both cases, we must conclude that the results are actually a product of a mental attitude on the part of those who control the situation. This becomes more and more evident as the progress of sales campaigns are scrutinized and compared in similar fields.

If it is true, as all the facts seems to indicate, that large sales successes are a natural outgrowth of a belief in the possibilities for large sales, coupled with a general disregard for unfavorable arguments, there is a powerful and it would sem an absolutely reliable principle on which to realize results.

Let us take for example the particular case of a central station in the West. The commercial department seemed to have been unconscious of all the stock arguments against heavy buying of

electric cooking ranges. It did not recognize the obstacle of high rates and consequently sold more ranges after the rates were substantially raised than they did when it was low, finding that it was simply a matter of educating the people.

The backwardness of the small town market also failed to register in the minds of this sales organization, and 250 electric ranges were sold in a town of 3500 population, with sales of 40 more assured for each month when these figures were announced. The salesmen further failed to note what is almost universally believed, namely, that the farmer is a very difficult prospect. They went ahead with electric range demonstrations in all the towns and rural districts in the country tributary to the company lines. They pointed out to the farmers' wives that their husbands had tractors with which to plow and automobiles in which to go and come, while they cooked over an old-fashioned stove with wood scarce and coal high. This gave them a line of thought and conversation that resulted in the sale of many ranges.

Briefly, it couldn't be done, but, not knowing that, the company did it. This attitude in merchandising might be cultivated with gratifying results. How much business is lost on account of salesmen's preconceived limitations and reservations would be hard to compute.

SOCIETY FOR ELECTRICAL DEVELOPMENT HAS MANY ACTIVITIES.

Many Requests for Special Service Come from Members Daily and Aid Is Given in Many Different Lines of the Industry.

If there is any doubt in the minds of central-station managers and others in the industry that the Society for Electrical Development does not give its members real concrete help in the various lines of business, a day or two spent in the offices of the corporation in New York City, where the staff could be seen at work on problems submitted to them, would speedily dispel the doubt.

The daily requests for special service run something along this line:

A central station is helping a local newspaper start an electrical page. The Society for Electrical Development is appealed to for help. Material for an electrical page goes forward promptly and more material follows each week.

A merchant who has a growing electrical shop feels the need of a trademark. He asks the Society for help and gets a number of suggestions from which he may choose. A contractor who is becoming a dealer-contractor needs assistance in arranging his new store. He asks the Society how to do it. A floor plan of his store is prepared, the display fixtures are located on the plan and every detail is fully worked out for him.

A jobber believes he should co-operate with the architects. He asks the Society for suggestions on how to do this and gets a number of them. A contractor-dealer wants to increase his motor sales and motor-repair business and decides on a series of letters as the best plan. The Society is asked to prepare them. It not only writes the letters but maps out a complete campaign for the member.

A manufacturer seeks a market for a new specialty and wants a lot of facts and figures about the present market and the field for his new product. Without fuss or delay the facts are forthcoming from the Society.

All this special service to members does not interfere with the weekly service to the electrical industry as a whole. Month after month special articles are contributed to popular magazines and week after week electrical news items go forth to daily newspapers. All this is done by the Society without taking up the time of anyone, excepting the members of the Society's permanent staff.

MINNEAPOLIS GENERAL ELECTRIC GAINING NEW BUSINESS.

The sales department of the Minneapolis General Electric Co. during the week ended Feb. 13 secured 182 new electric light and power customers with 100 kw. in lighting and 553 hp. in motors. New business connected to the lines of the company shows a gain of 58 customers with 36 kw. in lighting and 45 hp. in motors. Output of electrical energy was 26.1% greater than that produced during the corresponding period a year ago.

Nearly 1000 electric appliances were sold during the first two weeks in February, compared with a total of less than 400 during the entire month of last year. Contracts for wiring already built houses are double those secured last year in February. Building permits issued during January show a total valuation of $1,800,000. This is the largest single month's record in the history of Minneapolis, and compares with $180,000 during January, 1919.

COMMONWEALTH EDISON CO. TO ENLARGE ELECTRIC SHOP.

As a result of large increases in the sale of electrical appliances during the past year, the Commonwealth Edison Co., Chicago, has leased approximately 6000 sq. ft. of space on the ground floor of the Marquette building, which adjoins the Edison building, to obtain needed facilities for expansion of its electric shop.

The latter now occupies practically the entire ground floor of the Edison building and has entrances and show windows in South Clark and West Adams streets. The new space in the Marquette building will open into the present electric shop and will include an entrance and show windows on South Dearborn street.

MERCHANTS HEAT & LIGHT CO. HAS NEW PUBLICATION.

"A Light Publication With a Light Purpose" is the apt slogan adopted by the Merchants Heat & Light Co., Indianapolis, Ind., for its new monthly publication, "The Flash," the first issue of which has just come from the press. The publication is a 12-page folder, with L. G. Rothschild as publication manager, and is filled with matters of interest to those connected with the company.

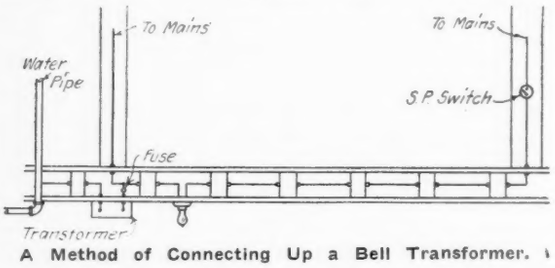
CONTRACTING-CONSTRUCTION

A Department Devoted to Various Problems Relating to the Installation, Operation and Maintenance of Electrical Equipment

CONNECTING A BELL TRANSFORMER.

By E. H. JACKEL.

On a recent occasion I was asked to install a bell transformer to replace a set of dead batteries. Conditions were such that much extra wiring was out of the question and I did the job as per sketch. It happened that the live wire



A Method of Connecting Up a Bell Transformer.

coming down was the neutral, so I changed the pair in the cutout cabinet, the neutral being grounded.

This was a case where the basement circuit was controlled by a single-pole switch. Whether this job is approved practice is not clear to me, but it certainly did the work easily.

MASTER SWITCH CIRCUITS.

By P. T. ELLIOTT

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Although there is no specific reference to master switches in the National Electrical Code, there is no limitation as to the number of switches that may be placed in any installation. Hence master switches may be installed without violating Code requirements. Where a master switch controls a load greater than 660 watts, the load must be divided between several branches and each must be protected by branch fuses, so that no branch will carry more than 660 watts.

INSTALLING CEILING HOOKS AND HITCH BLOCKS IN CONCRETE.

Electrical machinery is often heavy for its size, as compared to other forms of machinery, because of the large amount of copper and iron used in its manufacture. The problem of handling this sort of machinery in industrial plants, etc., thus becomes one of importance, especially when headroom and space is not available and the usual methods of rigging are necessarily lacking.

In reinforced concrete buildings it is expensive and troublesome to cut holes in floors after the structure has been built. The remedy is to make provision before or as the work progresses for holes, foundation bolts, hitching plates, etc. The accompanying illustrations show two typical methods of installing hooks or hoist plates in the ceilings of reinforced concrete buildings so as to facilitate hoisting such apparatus as transformers, circuit-breakers, regulators, etc.

Fig. 1 shows a method often employed where a chain is to be strung up to which a block and tackle or hitch block is to be fastened. When pouring the concrete, a piece of wood is inserted

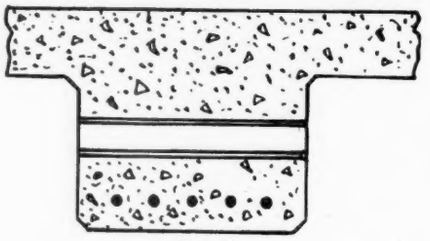

Fig. 1.

in the form so as to keep the hole open. Into this hole, later when the form is taken down, is inserted a piece of steel pipe to make a good tight fit. In Fig. 2 is shown a method of installing a floor or ceiling plate into which a crane hook is screwed. Two forms of floor plates are shown, the one for use where the floor is thick, the other where the floor is thin. Both serve the same purpose, and each will be found the more pref-

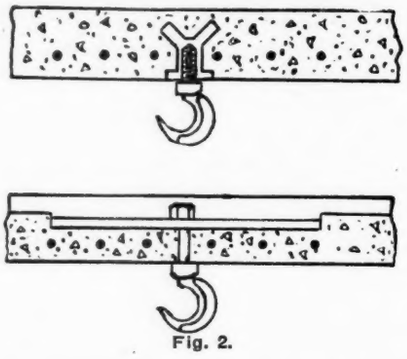

Fig. 2.

erable under certain circumstances. The existence of hoist hooks or the like, etc., directly above apparatus that may need hoisting quickly often proves invaluable for saving time and service.

CARRYING CAPACITY OF COPPER WIRES.

By HERBERT A. LANE.

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We have often tried to find some data regarding the safe current carrying capacity of copper wires used in testing work or any other similar temporary work where the wirse can always be watched but have never been able to locate anything conclusive. From our own experience, however, we believe that for leads, for temporary testing work, insulated conductors will safely carry currents about double those given as safe values in Rule 18 of the National Electrical Code.

Proposed Changes in the National Electrical Code—III

Principal Recommendations for Revisions Made in Reports by Standing Committees of the Electrical Committee, N. F. P. A.

COMMITTEE ON OUTSIDE WIRING, BUILDING SUPPLY AND SERVICES.

This committee recommended quite general revision of Rule 12 on outside wires, to read as follows:

(a) **Service** wires must have an approved weatherproof or rubber insulating covering, **except that services of multiple-conductor cable from pole to building must in all cases have an approved rubber insulating covering.**

Service wires between main cutout and switch and the first support from the cutout and switch on the outside of building must have an approved rubber insulating covering, but from above-mentioned support to the line, except when run in conduit **or cable,** may have an approved weatherproof insulating covering.

On exterior walls of building, services of multiple-conductor cable and all service wires liable to come in contact with awnings, swinging signs, shutters or other movable objects must be enclosed in approved conduit.

For conduit work, the general rules for conduit installations must be followed and the conduit system must be **weatherproof.**

Wires used for service connection must not be smaller than No. 10 B. & S. gage, if of soft copper, or smaller than No. 12 B. & S. gage, if of medium or hard-drawn copper.

(b) Light **and service** wires must be so placed that moisture cannot form a cross connection between them, **and** must not be in contact with **anything but** their supports. **They** must be not less than 1 ft. apart except when in conduit or multiple-conductor cable **or on approved racks or brackets.**

Multiple-conductor cable service must be supported at least 6 ins. from adjacent woodwork and at least 12 ins. from overhanging projections of combustible material unless approved supports are used which interpose an equivalent protection to such woodwork.

(c) **Wires** must be at least 8 ft. **from** the **nearest** point of **buildings** over which they pass, **and if** attached **to roofs** the roof structures must be substantially constructed. Wherever feasible, wires crossing over buildings should be supported on **structures which are** independent of the buildings.

(d) **Wires** exposed to the weather **must be supported on** petticoat insulators, **except that, on low-potential systems, approved wiring brackets, racks, supports or insulators may be used.**

Wires on the exterior walls of buildings **and not protected by the service cutout** must be supported at least every 15 ft., the distance between supports to be shortened if wires are liable to be disturbed. **With approved racks or brackets a spacing of 6 ins. between wires will be permitted if supports are not more than 9 ft. apart, wires are kept taut and so mounted as not to come into contact with each other or with the building, or other object. Wires must be kept at least 2 ins. from the surface wired over.**

[Third paragraph same as present second paragraph of 12d.]

(e) **Wires** must be so spliced or joined as to be both mechanically and electrically secure without solder. Joints, **unless made with some form of approved splicing device,** must be soldered; and **all joints must be** covered with insulation **as good as** that on the conductors.

(f) **Wires not enclosed in conduit must, where they enter buildings,** have drip loops outside, and the holes through which the conductors pass must be bushed with noncombustible, nonabsorptive insulating tubes slanting upward toward the inside.

For a low-potential system the service wires may be brought into the building through a single iron conduit, the conduit to be equipped with an approved service head. The inner end **of the service conduit must enter a cabinet containing the service cutout or be made up directly to an equivalent device enclosing all live metal parts, located at the nearest accessible place to a point where it enters the building and inside the wall, except that a service conduit need not be connected electrically to a grounded cabinet or other grounded fitting if insulated from ground and, if necessary, isolated or guarded as provided for short lengths of conduit in Rule 15A, Section n.**

(g) Electric light and power wires must not be placed on the same crossarm with telegraph, telephone or similar wires, and when placed on the same pole with such wires the distance between the two inside pins of each crossarm must not be less than 24 ins. **for circuits not exceeding 300 volts to ground and not less than 30 ins. for circuits of higher voltages.**

Rule 13. Amend third paragraph of introductory fine-print note to read:

It is fully understood that it is impracticable to include in this Code rules which will cover in detail all conceivable cases that may arise in construction work of such extended and varied nature and it is advised that this Department be freely consulted as to the specific methods to be followed in particular cases.

In Rule 13*b*, third line, change word "lines" to "conductors."

Change last sentence of Rule 13*c* to read:

In every case ample clearance between such high-voltage wires and all other wires and supporting structures shall be provided.

Substitute for the entire Rule 13*d* the following:

Where such lines cross other lines, the poles **supporting the conductors at the higher level** must be of heavy and substantial construction.

In Rule 13*e*, fifth line, after word "building" add "not more than three stories or 50 ft. in height"; omit last line of table; add at end of rule the following paragraph:

Where buildings exceed three stories or 50 ft. in height lines must not be brought closer than 6 ft.

Omit Rule 17*b* and insert the following as 16*i*:

The wiring in any building or group of buildings, including the service connections thereto, shall be so arranged as not to serve as a shunt around any street fuse or switch.

In Rule 23*a*, omit from first paragraph the words "and inside the walls"; omit the second paragraph of the 1915 edition which has been reinstated in the 1918 edition.

Rule 24*a*, insert in seventh line of second paragraph after the words "no parts" the following: **"except potential coils of the meter."**

Insert between second and third paragraphs the following:

Except when mounted on a switchboard under competent supervision, the service switch must be inclosed in an approved box or cabinet of such a

type that the switch may be operated without opening the cabinet.

Substitute for Rule 45 the following:

45. Oil-Immersed Transformers. *(See also Nos. 11, 14, 15 and 36. For construction of transformers see No. 81.)*

(a) Transformers must not be placed inside of buildings other than power stations and substations without special permission. Where oil-immersed transformers are permitted in other buildings, they must be enclosed in fireproof vaults constructed as follows:

1. The enclosure must consist of concrete not less than 6 ins. in thickness or of brick not less than 8 ins. in thickness, except that when the total transformer capacity so enclosed is not over 100 kv-a. the above thickness may be reduced to 4 ins., provided approved fireproof material is employed and the construction of the vault is specifically approved by the inspection department having jurisdiction. Outside walls of the building, if of fireproof construction, should preferably constitute one or more of the walls of the vault or enclosure.

2. Transformer vaults or enclosures must be provided with means for ventilation which will prevent the development of room temperatures in excess of those at which the transformers installed therein may be safely operated. Limiting temperatures shall be determined in accordance with and in the manner prescribed by the Standardization Rules of the American Institute of Electrical Engineers and temperature rises under full load should not exceed 40 deg. C. All ventilation openings shall be provided with automatic or manually controlled dampers to prevent the emission of smoke or fire. Damper controls should preferably be arranged to be operated from a point outside of the vault.

3. A suitable drain must be provided which will carry off any accumulation of oil or water that may collect in the vault. Floor and drain shall have a pitch of not less than ¼ in. per foot. In vaults containing transformers having a total capacity of 100 kv-a. or less the drain may be omitted if the enclosure is so constructed as to retain all of the oil used within the vault, when transformer cases fail.

4. Unless opening is from the outside of building only, the doorway to the vault must be thoroughly closed by means of an approved tight-fitting fire door. A door sill not less than 4 ins. in height must be provided. In all cases the sill must be of sufficient height to confine within the vault the oil from the largest transformer installed.

(b) It is recommended that when oil switches are used to control transformers, such switches be located within the vault or enclosure.

(c) Transformers must be placed in a fireproof enclosure with an air space of at least 6 ins. on every side. The enclosure must be securely locked, and access allowed only to authorized persons.

(d) The transformer case must be permanently and effectively grounded **in accordance with No. 15A.**

Substitute for Rule 47 the following:

47. Wires.

Wires must not be brought into or over buildings, except power stations, substations, **or transformer vaults complying with No. 45a.**

Rule 48. Insert a new rule as follows:

48. Transformers.

Transformers installed inside buildings except power stations and substations must comply with No. 45.

COMMITTEE ON SIGNALING SYSTEMS.

This committee made a detailed study of Rule 85 on signaling systems and recommended quite a few changes, which the committee itself has summarized as follows:

Add two paragraphs to Section *a* to provide for standard separation or protection of wires on outside walls of buildings, and the interruption of the lead sheath of aerial cables at point of entrance to building when cable is exposed to contact with light or power wires.

Revise black-face heading following Section *a* to permit the omission of protectors, etc., where wires are carried underground to a block and therein distributed overhead, provided wires are not exposed to contact with light and power wires carrying more than 250 volts potential.

Revise note in italics at the end of Section *b* to indicate the types of cables that are suitable for making entrances into buildings.

Revise Section *c* to permit the use of rubber-covered wire made specially for signal work, also conductors of other material than copper.

Revise Sections *d* and *e* to permit the omission of drip loops where entrance tube is pitched to prevent entrance of moisture and permit the use of conduit for service entrances.

Abolish classification of systems based on carrying capacity and establish uniform requirements for protectors on all signaling systems. This means the omission of Sections *f*, *g*, *h* and *i*; also the heading in italics on pages 175 and 176 of the 1918 Code and in rearrangement of the lettering of sections to conform to plan.

Slight changes are proposed in 1918 Code Section *k* to permit conduit work and in Section *l* to require mechanical protection for ground wire where needed, and special rubber-covered wire for signal purposes.

Revise Section *m* by omitting test requirements and heat-coil requirement; the test details to be established by Underwriters' Laboratories after careful investigation and conference with companies employing protectors.

COMMITTEE ON THEATERS, MOTION PICTURES, PLACES OF PUBLIC ASSEMBLY AND GARAGES.

Theaters.—The present rules on theaters have been found quite satisfactory, so the committee recommends change only of Rule 38*c*, first paragraph to read:

c. Switchboards.

1. Must be of **the dead-front type and made of** noncombustible nonabsorptive, insulating material.

Switchboards must comply with the requirements of Rule 3 **and in addition must have a metal hood over the top running the full length of the board and fully protecting same from anything falling from above.**

Motion Pictures.—Change heading of Rule 38A to read: "**Motion**-Picture Factories, Studios, **Exhanges,** and Motion-Picture Equipments."

Rule 38A*e*; change heading to read as follows with explanatory note following:

Motion-Picture Equipment **for Use Only in Fireproof Booths.**

In this class of equipment are included the so-called professional types of machines, such as are commonly used in theaters, motion-picture houses and elsewhere where protection against the hazards involved is provided not only by the construction of the equipment but also by its location, enclosure and other features of its installation and use.

1. Add sentence as follows:

Outlets for motion-picture projectors must be wired with wire not smaller than No. 4 B. & S. gage.

8. Add new paragraph as follows:

Rewinding of films must be done in the booth if feasible, and if not in a separate fireproof compartment provided for the purpose.

9. Add new paragraph as follows:

Motor-Generator Sets.—When motor-generator sets are installed within the booth, the commutator end or ends of the machine must be suitably pro-

tected against mechanical injury by wire screen or other suitable means.

Rule 38A*f*; change heading to read as follows with explanatory note following:

Motion-Picture Equipment for Use Without Fireproof Booth.

In this class of motion-picture equipment are included all types of machines for use without other protection than that afforded by the construction of the machine itself.

Elevators.—A special subcommittee representing inspection departments and elevator manufacturers studied the need of rules for wiring elevators and recommended insertion of a new rule, to be known as No. 43A and to read as follows:

43A. Electric Elevator Wiring.

All wiring, apparatus, etc., not specifically covered by special rules herein given, must conform to the general requirements of this Code.

a. A switch disconnecting all wires of the motor circuit must be located within sight of the motor, except in cases where special permission to locate it elsewhere is given in writing.

b. The wires of motor circuits between motors and controller panel may be grouped together without any extra insulation of the separate wires, provided the complete group is either taped or corded and painted in a manner to make same a rigid, self-supporting form, not over 3 ft. long and not in a position liable to mechanical damage or subject to a temperature in excess of 120 deg. (49 deg. C.).

c. All conductors between main circuit resistances and the back of control panels must each have a substantial flameproof outer covering. (See Rule 4, Section c).

All other wires on controller panels may be of rubber-covered wire, provided they are laid flatly against the slate of the panel and held in position in such a manner that their movement and damage to their insulation is nil and not liable to a temperature in excess of 120 deg. F. (49 deg. C.).

In some few cases it may be necessary to bunch some wires of the operating circuit on the back of controller panel. This may be done provided same are taped and painted with an insulating paint.

d. The flexible or traveling cables of the operating and lighting circuits must have an approved insulating covering as called for by rules in Class C for similar work, and must have a substantial flameproof outer covering. The cable may be run in approved conduit properly bushed as for single conductors or it may be run open over the outer surface of the cab to fixtures and switches within the car.

e. Conduit or armored cable attached to elevator cars need not be grounded as required by Rule 15A.

When elevator motors and motor-generator sets are mounted on metal beams which form part of the structural metal frame of the building, they will be considered as complying with Rule 15A.

f. Approved split tees and elbows may be used for all circuits except feeders.

g. All signal system wiring, except when energy is supplied by primary batteries or approved bell transformers, must be encased in approved metal conduit and equipped with an approved bushing as for single conductors.

h. In garages, hatch-limit switches or other spark-emitting devices must be not less than 4 ft. above the line of the lowest floor level.

i. Electrical conductors in elevator shafts except lighting and control cables must be encased in approved metal conduits or armored cables. (See Rule 16, Section g.)

j. Approved strain insulators must be placed in the shifting cable, or the shifting cable must be grounded as required by Rule 15A.

k. Conductors for elevator lighting cables shall not be smaller than No. 14, and for elevator control cables not smaller than No. 16 B. & S. gage. (See Rule 51.)

Garages.—The committee recommends revision of Rule 42*e* to read:

e. Cutouts, switches and receptacles must be placed at least 4 ft. above the floor. **Cutouts and switches must be installed in approved cabinets except as provided in Section g.**

Hatch-limit switches of elevators must be at least 4 ft. above the line of the lowest floor level.

Portable tire-inflating motors, if not located at least 4 ft. above the floor must be of the fully enclosed type. Cutout and switch, if attached to portable apparatus must be surrounded by an approved cabinet.

COMMITTEE ON WIRING STANDARDS AND SYSTEMS.

This committee recommended revision of all of Rule 28*i* with its three tables as follows: Insert the following below the heading of this rule:

These tables apply only to complete conduit systems and do not apply to short sections of conduit used for the protection of exposed wiring from mechanical injury.

In place of the present first table substitute the table for two-wire and three-wire systems recommended by the Western Association of Electrical Inspectors and published in ELECTRICAL REVIEW, Feb. 14, 1920, page 287. Retain as Table 2 the present table on three-conductor convertible system. In place of the present single-conductor-combination, substitute the table for stage pocket and border circuits recommended by the above association and published in the above issue.

Wattage Limits for Branch Lighting Circuits.—In Rule 23*d*, second paragraph, strike out the first three words "By special permission"; in fourth line insert "maximum base" before "keyless"; change 1320 to 1500 in the eighth line. Add the following to the second paragraph:

Where the location of sockets and receptacles is such as to render unlikely the attachment of flexible cords thereto, circuits supplying sockets or receptacles of the mogul type only not having fiber or paper lining may be so arranged that not more than 4000 watts will be dependent upon the final cutout. Mogul sockets and receptacles, and fixtures with which they are used must be wired with conductors of not less than No. 12 B. & S. gage. Taps from circuit wires to points of suspension of such sockets, receptacles and fixtures must not be over 18 ins. in length.

Rule 34; substitute the following for Section *a*:

Must be so grouped that not more than 4000 watts will be dependent upon one cutout. Fixtures must be wired with conductors of not less than No. 12 B. & S. gage. Taps from circuit wires to points of suspension of such fixtures must not be over 18 ins. in length.

Rule 35; strike out Section *a*.

In line with the recommendation above that 1320 be changed to 1500 in Rule 23*d*, it is suggested that this change be made in all similar sections of the Code, namely, 23*d* sixth paragraph, 37, 38*d*, 83*e*2, 39*f* and 83*f*.

Rule 26*g* to *j*; drop the words "In dry places," under the heading "For open work." Change table in Section *h* to read as follows:

In dry or excessively hot places.

	In dry or excessively hot places.		Where exposed to dampness or injurious fumes.	
Voltage	Distance from surface.	Distance between wires.	Distance from surface.	Distance between wires.
0 to 300	½ in.	2½ in.	1 in.	2½ in.
301 to 550	1 in.	4 in.	1 in.	4 in.

Assign the letter *i* to paragraph beginning "Must not be dead-ended, etc." Omit italicized heading following new Section *i*. Omit present Sections *i* and *j*. Add a new Section *j* to read as follows:

j. Where exposed to dampness, rubber insulation

must be used. Where exposed to fumes injurious to rubber, weatherproof insulation must be used. Where exposed to excessive heat, slow-burning insulation must be used. Where the environment is such that rapid deterioration of wires or insulation may take place, the inspection department may require the wires to be suitably enclosed, coated or otherwise protected to better withstand the particular conditions of service.

Rule *26n*; add sentence reading: "Must be stranded for all conductors No. 6 B. & S. gage and larger."

Farm Lighting Plants.—On account of the special hazards of the now common 32-volt farm lighting and power plants, a special rule covering them was recommended (but no number as yet assigned to it). It reads as follows:

50 Volts.

1. Definition.

Isolated Light and Power Equipments for Less Than

Isolated and Power Equipments included in the intent of the following rules are those deriving their electrical energy from a combination of a stationary internal-combustion engine (with its necessary fittings) connected to an electric generator either with or without an auxiliary storage battery with its control devices, and operating at less than 50 volts.

Equipments operating at over 50 volts are not included in these rules, but must comply in all respects with the other requirements of this Code.

2. Engines, Fuel Tanks and their Accessories.

Shall comply with the installation requirements of the National Board of Fire Underwriters.

3. General.

In the use of lighting equipments with operating voltages less than 50 volts special attention is needed regarding the size of all conductors (wires, cords, fittings and devices) to assure safe carrying capacities for the larger currents required to accomplish the results as compared with ordinary commercial circuits of higher voltages.

In the following requirements consideration is not given to the question of voltage drop.

The following sections give the more important items for which special provision is required. In all other respects the general provisions of this Code shall be followed so far as they apply.

4. Sizes of Wires and Cords.

a. Wires and cords shall comply with Rules Nos. 16 and 18.

NOTE. While compliance with Nos. 16 and 18 will in many cases provide conductors of adequate size, both for safe carrying capacity and for efficient operation, the use of conductors of sizes given below is strongly recommended in order to provide a greater factor of safety in view of a possible increase in connected load with consequent overloading of circuits, increase in voltage drop, and decrease in operating efficiency.

1. Branch lighting circuits of not less than No. 12 B. & S. gage.
2. Portable cords of not less than No. 14 B. & S. gage for circuits of over 6 amperes; No. 16 B. & S. gage for all other cords.
3. Circuits supplying portable devices (heaters, motors, etc.) requiring more than 6 amperes to be of not less than No. 10 B. & S. gage.
4. Fixture wires and pendent cords of not less than No. 16 B. & S. gage.

5. Devices and Materials.

(a) All devices and materials shall be of approved types complying with all requirements for devices and materials for low-potential systems.

(b) Medium-base sockets rated at 250 volts, 250 watts may be used with maximum current of 3½ amperes.

6. Automatic Cutouts.

(a) All equipment shall be so arranged that no set of small motors, heating devices or incandescent lamps, whether grouped on one fixture or on several fixtures or pendants (nor more than 8 lamp sockets or receptacles), requiring more than 320 watts shall be dependent on one cutout.

Lamp sockets and receptacles will be considered as requiring not less than 40 watts.

(b) Fuses for branch lighting circuits shall not be larger than 10 amperes.

7. Heaters and Portable Devices.

(a) Circuits supplying portable devices requiring more than 6 amperes (heaters, flatirons, motors, etc.) must be of not less than No. 12 B. & S. gage and must be run as separate circuits, each supplying a single receptacle for an attachment plug of suitable current rating.

(b) Receptacles for attachment plugs for portable devices taking more than 12 amperes must be of types approved for low-potential circuits and rated at not less than 20 amperes.

(c) Each heater of more than 6 amperes or 192 watts capacity must be protected by a cutout and controlled by a switch plainly indicating whether "on" or "off," or plug connector, and located within sight of the heater and arranged to cut off all current from the device. Heaters of 6 amperes or 192 watts capacity or less may be grouped under the protection of a single set of fuses provided the rated capacity of the fuses does not exceed 10 amperes, or may be connected individually to lighting circuits when the normal load in use on the circuit at any time will not exceed 320 watts.

Switches, attachment plugs, and similar fittings must in all cases be of suitable capacity for the current carried.

With portable heating devices, approved plug connectors must be used so arranged that the plug may be pulled out to open the circuit without leaving any live parts so exposed as to render likely accidental contact therewith. It is preferable that the plug should not be on the device itself.

Each electric heating, cooking, or utility device must be provided with a nameplate giving the maker's name and the normal capacity in volts and amperes or in volts and watts. Each such device of more than 6 amperes or 192 watts capacity must be equipped with a type of plug which cannot be connected into medium-base lamp sockets.

It is strongly recommended that each electric heating, cooking or utility device or group of such devices be used with approved signal or with approved protective devices.

The committee also recommended several minor changes, of which the most important is addition to Rule 18 of the following:

Conductors may be placed in multiple only under special permission in writing from the inspection bureau in charge.

COMMITTEE ON RECONCILING NATIONAL ELECTRICAL CODE AND NATIONAL ELECTRICAL SAFETY CODE.

This committee recommended amendments as follows:

Rule 15, Section *b*; insert after the word "except" at end of first line the words **"furnace circuits and."**

Rule 15*A*, Section *m*; in second paragraph, change "15 amperes" to read **"10** amperes" and "No. 14" to read "No. **16."**

Rule 15*A*, Section *n*; in third paragraph, insert after the word "No." at beginning of fifth line the words **"12f and."**

Rule 15*A*, Section *s*; in third line of first paragraph, change "4" to **"2"** and add at end of paragraph: **"Where facilities are not available for determining the resistance of the ground connection, the exposed surface must not be less than 4 sq. ft."**

Rule 19, Section *a*, at end of first paragraph, add: **"A disconnecting strap may, however, be employed in lieu of a switch blade for the grounded conductor."** Rule 24, Section *a*; at end of first paragraph, add an identical sentence.

In the way of co-operation in reconciling the two codes, the Bureau of Standards has agreed to modify the Safety Code in several places, especially in its Rules 304*d* and 310*d*.

NEW APPLIANCES

Newly Developed and Improved Electrical and Mechanical Apparatus, Appliances, and Devices Now Being Placed on the Market

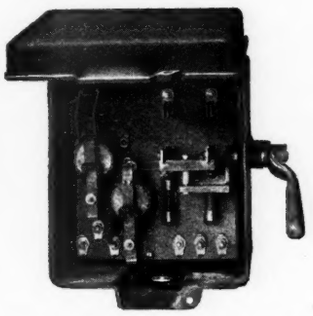
New Direct-Current Automatic Starter.

An automatic starter of the inclosed type which may be operated by a self-contained knife switch with external handle or controlled from a remote point by a push-button master switch has recently been put on the market by the Cutler-Hammer Manufacturing Co., Milwaukee and New York. The starter is adapted for small d-c. motors driving machines in light manufacturing operations where protection is wanted for the operator as well as the motor.

The equipment consists of an automatic motor starter panel of the counter e. m. f. type completely inclosed in a cast-iron case with a hinged cover. The automatic feature is obtained by an accelerating contactor which closes when the motor attains about three-fourths full speed and automatically shunts out the starting resistor. A magnetic main-line contactor mounted on the panel allows remote control from two push-button switches of the momentary contact type. The operation of the contactors in conjunction with

Automatic Starter Operated by External Lever or Push-Button Switches.

the push-button switches is as follows: Pressing the "run" button closes the magnetic main-line switch, thereby starting the motor with the armature resistor in circuit. The motor accelerates until it reaches about three-fourths normal speed, when the resistor is automatically cut out of circuit by the closing of the accelerating contactor, the operating coil of which is connected across the motor leads and is energized by the counter e. m. f. of the armature. The motor is stopped by pressing the "stop" button or by voltage failure, which causes the main-line contactor to drop out. By using a separate field rheostat speeds above normal can be obtained if the speed range does not exceed two to one. A common snap switch, a float switch or a pressure regulator can also be used for remote control of the motor. When remote control is not desired the magnetic main line contactor is omitted, and the motor is controlled by a fused knife switch mounted on the panel with an operating handle outside of the case. The handle can be locked in the open position to prevent unauthorized operation. Interlocks prevent lifting the cover while the switch is closed or throwing the switch with the cover opened. When the knife switch is used, low-voltage



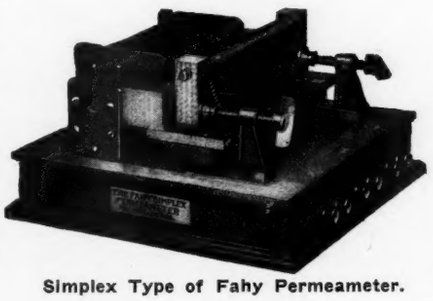
Automatic Starter With Cover Lifted for Renewing Fuses.

release is inherent in the accelerating contactor. Low-voltage protection is provided with three-wire push-button control. The inclosing case is arranged for conduit wiring and can be mounted on a wall or any flat surface. This starter is for use with small d-c. motors not rated over 2 hp. at 115 volts or 3 hp. at 230 volts.

New Instrument for Magnetic Testing.

A new form of permeameter for determining the maguetic characteristics of materials has been placed on the market by Holz & Co., 17 Madison avenue, New York City. It is called the Fahy permeameter and may be used for obtaining information in regard to the magnetic characteristics of materials to be used in the design of electrical machinery or in order to determine their quality, or predetermine their mechanical performance.

The instrument is made in two types —compensated and simplex. The compensated type is designed not only for the testing of single specimens of ma-



Simplex Type of Fahy Permeameter.

terial but also for the simultaneous comparison of the magnetic properties of two specimens, one of which is considered as standard. For example, the standard specimen may be a heat-treated steel known to possess certain mechanical and magnetic properties and the other steel a product which it is desired to compare with the standard. When it is not necessary or advisable to employ the method of simultaneous comparison, a simplified form of the permeameter can be used—the simplex type, which possesses the other features of the compensated type but is designed to test only one specimen at a time. With the simplex type, however, two or more specimens can be compared by the results of consecutive tests, and its advantage over the compensated type lies in simplicity of design and operation. Special control boxes, containing the adjusting resistance, switches, ammeters, contact keys, etc., have been designed for use with these permeameters.

Color-Matching Light for Use on Store Counters.

A color-matching light is what the National X-Ray Reflector Co., Chicago, calls its new "Tru Da Light"

Counter Lamp Available for Color-Matching Purposes.

fixture. The fixture is designed mainly for use on store counters where special light is needed. No special colored lamps or diffusing plates are used, the white light being secured from the "Tru Da" blue grass X-ray reflector. The unit stands 16½ in. high and is economical in current, requiring only a 25-watt Mazda lamp.

Machine for Tieing Insulators to Live Line.

Some time ago a machine for safely tapping a branch distribution line to a live main line was brought out by the Bush Electric Co., Cleveland, O. The company has recently developed an attachment for use in connection with this machine for the purpose of tieing replacement insulators onto the line without killing the line. The tie wire is attached to the insulator with the two tie ends left sticking up so they will be on opposite sides of the line wire when

it is lowered down on top of the new insulator. The tapping machine with attachment is then slipped over the main line wire on one side of the insulator. The loose end of the tie wire is picked up automatically by the attachment and closely pig-tailed out

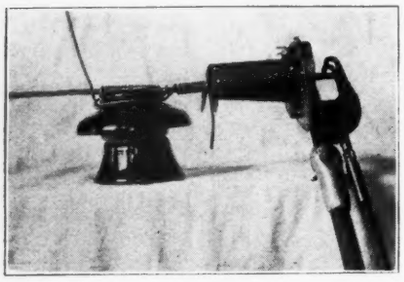


Fig. 1.—Machine for Attaching Insulators to Live Line.

along the main-line wire in the same manner as a man would do it by hand. This operation is then repeated on the other side of the insulator. Even a new arcing shield can be wrapped on with this attachment.

Fig. 1 shows the tapping machine and

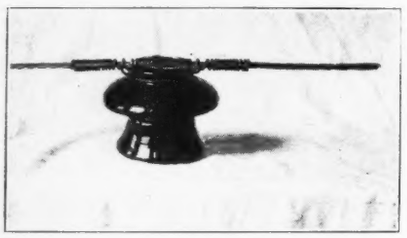


Fig. 2.—Insulator Attached to Live Line by Tapping Machine.

attachment finishing the pig-tail on one side of the new insulator.

Fig. 2 shows the finished job. The manufacturer supplies complete insulator-changing equipment for pin, suspension or dead-end insulators.

Improvement in Wheeler Vertical Condenser.

A new feature of the latest design vertical condenser manufactured by the Wheeler Condenser & Engineering Co., Carteret, N. J., is the vertically split casing of the tail pump.

This feature permits easy and quick removal or inspection of the pump rotor or other internal part. It is now simply a matter of removing the bolts and cover, and uncoupling the rotor. Before this design was developed, considerable time was required to get at and remove the rotor.

The improvement is now being added to two types of jet condensers manufactured by this company—the vertical jet condenser and the rectangular type counter-current condenser.

Another feature worthy of note is the expansion joint between the pump and the condenser body. This joint is designed to take care of any changes in length due to temperature fluctuation. In some installations the expansion joint is not recommended, hence condensers are made with or without the joint, depending upon the conditions in the plant.

The primary advantage of the Wheeler jet condenser lies in the fact that it utilizes the heat-absorbing capacity of the cooling water to the greatest degree, discharging it from the bottom of the condenser at practically the same temperature as the steam. At the same time the outgoing non-condensible gases come into contact with the water entering at the top of the shell, and are therefore cooled to the lowest temperature.

Referring to the illustration herewith, steam and water enter at the top. The water is discharged in stream through spiral nozzles, which break up the water current into a rain or spray to insure the desired steam-condensing capacity. The condensed steam and water fall to the bottom of the condenser, where they are removed by the submerged centrifugal pump. The air is removed through an opening just below the cone of the condenser, a small amount of cold water being allowed to fall just in front of the air outlet, thus cooling these gases to their smallest volume.

In connection with these condensers, a turbo-air pump or a three-stage steam jet air pump is usually recommended.

Automatic Arc Welder.

Automatic arc welding will be accomplished by a new device, perfected by the General Electric Co., Schenectady, N. Y., and soon to be put on the market, which is known as the automatic arc welder. This welder, for use with the regular welding set, is designed to take the place of the hand-controlled electrode. It consists of a pair of feed

Split Casing of Tail Pump for Wheeler Condenser.

rollers, called feed rolls, driven by a small d-c. motor, which draw in and deliver to the arc a steady supply of wire, and automatically maintain the best working distance. The whole is controlled from a small panel.

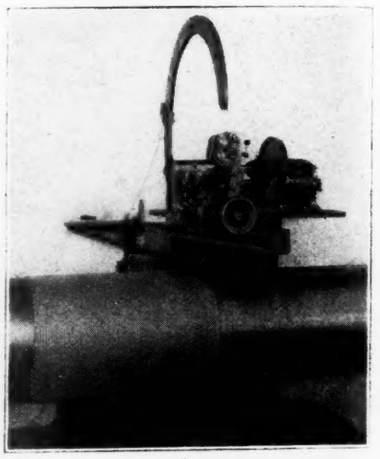
The welding head is held by a suitable support with a certain amount of hand-regulated adjustment, and consists of a steel body carrying feed rolls and straightening rolls which are both adjustable for various sizes of wire. The arm is supported on a gear box, together with the motor. This box contains gears which give three gear ratios, thus extending the range of the device while allowing the motor to operate at its most favorable speed.

The control panel carries an ammeter and voltmeter for the welding circuit, as well as rheostats, a control relay, and the contactors and switches for the feed motor. It is possible to start and stop the equipment from the work by a pendant push button, but adjustment of the feed conditions must be made from the panel.

The adjustment for arc conditions by regulation of the speed of the feed motor, as the arc voltage varies, is taken care of by the panel equipment. The result is a practically steady arc, which is greatly superior in smoothness of operation to any hand-controlled arc, consequently increasing the speed of the welding.

The whole apparatus is mounted on a base which can be bolted to any form of support. Thus a great variety of working conditions can be met, but provision must be made for carrying the arc at uniform speed along the weld. For instance, for straight seams, a lathe or planer bed may be used, and for circular ones, a lathe or boring mill. The local conditions dictate the method to be followed.

The manufacturers claim the device is especially valuable where a large



Automatic Arc Welder Increasing Diameter of Shaft.

amount of routine welding is to be done, since it is capable of from two to six times the speed possible to skilled operators and gives a uniform weld of improved quality. It is adaptable to welding seams of tanks and plates, rebuilding worn or inaccurately turned shafts (as shown in the illustration), rebuilding worn threads and flanges of wheels, and many other kinds of work.

Simple Construction Is Claim Made for New Battery.

Simplicity in construction, combined with strength and durability, is the claim made for the "Red Seal Sparker," a new device put on the market by the Manhattan Electrical Supply Co. A specified number of "Red Seal" dry cells, properly and permanently connected together, are put into a moisture-proof container. The cells are perfectly insulated from one another and hermetically sealed in the container, so

New Dry Battery Unit.

that only the two terminal binding posts and a carrying strap protrude through the sealing compound. The terminal nuts on the binding posts are embedded in a square shaped knob of insulating material, so that a wrench or strip of metal accidentally in contact with both binding posts will not cause a short-circuit.

ACTIVITIES IN THE TRADE

Business Developments, Sales Agencies, Trade Literature and Miscellaneous Items Concerning Electrical Manufacturers and Allied Business Interests

Amber Electrical Supply Co., Chicago, will start construction work this spring on a $250,000 7-story mercantile building at the southeast corner of Adams & Desplaines streets. Adolph H. Bernstein is owner of the company. Minchin & Weller, architects, have drawn plans for a structure to cover 68 by 75 sq. ft.

Ryan Manufacturing Co., Inc., 345 West Broadway, New York City, has put on the market the Ryan time limit switch, a device to automatically turn off lights that is applicable for use in apartment house corridors, hallways, storerooms, show windows, electric signs, etc., where it is desired to turn lights off at a certain hour.

Benjamin Electric Manufacturing Co., Chicago, managers and executives held a dinner meeting at the Hotel Morrison, Chicago, Feb. 23, at which a number of interesting ideas were exchanged. The dinners are informal events and the underlying idea is to get as much self-help out of the meetings as possible. About 100 department heads from the various Benjamin plants attended the dinner, at which Waldemar Kaempffert, editor of *Popular Science Monthly,* was the principal speaker.

Utility Products Corp., 50 Church street, New York City, has closed a contract with the Electrical Development & Machine Co., of Philadelphia, to handle the latter's goods in the eastern territory. The line covers buss-bar supports, disconnecting switches, non-arcing high-tension fuses, the latter a recent development, and other electrical devices. The Utility Products Corp. has recently been formed with G. A. Thomson, formerly eastern sales manager of the Adams-Bagnall Electric Co., of Cleveland, as president. The corporation also represents in the eastern territory, A. S. Wade & Co., Pittsburgh Electrical Specialties Co., National Pole Co., Wellington Glass Co., and Wagner Electric & Manufacturing Co.

United States Rubber Export Co., Ltd., 1790 Broadway, New York City, which is the export division of the United States Rubber Co., is adding to its facilities for the exportation of rubber-insulated electrical wires, cables, tapes, etc., as manufactured at its Bristol, R. I., plant. Already 12 direct branches and numerous distributors, carrying stocks of these commodities, as well as other products of the company, are being successfully operated in important centers of the world. Thoroughly trained representatives are operating in restricted territories throughout the world, looking after the interests of the distributors and introducing the sale of American-made wire and other allied products. The promotion of wire and cable sales is handled from the New York office, with H. C. Morehouse in charge of the work.

Edison Electric Appliance Co., Inc., 5660 West Taylor street, Chicago, is offering to the trade large color enlargements of "Hotpoint" electric iron advertisements that are now running in the *Saturday Evening Post* and *Ladies' Home Journal.* The object is to have dealers display them in their stores and windows in connection with sales campaigns on "Hotpoint" irons.

Aetna Electric Appliance Co., Boston, Mass., has placed on the market its new "Hotvent" electric water heater, which furnishes "Hot Water on the Run" and will heat enough for a bath in 15 minutes. The heater is of all-brass construction, is rustless and being made in all sizes will fit any tank. The heaters may be wired to turn on and off in both the kitchen and bathroom and are easy to install and economical to operate, the manufacturer claims.

Marlin-Rockwell Corp., New York City, has issued a booklet describing the company's claims for "Rockbestos," the new asbestos-covered wires and cables manufactured by the company. A preface to the booklet says that it has been written with the object of informing the electrical industry concerning "Rockbestos"—an asbestos insulation for all types of electrical conductors which is fireproof in fact as well as name. After a description of the asbestos processes the booklet gives information, illustrated with cuts, of the different varieties of "Rockbestos" wires and cables.

F. W. Wakefield Brass Co., Vermilion, O., is sending out its new catalog No. 120, announcing several new lines of lighting fixtures. It is pointed out that these lines are so arranged and standardized as to appeal particularly to dealers and contractors serving the great middle-class demand. The lines are named "Homeric," "Heroic," "Heraldic" and "Hendrick," and consist of assortments to meet every standard need. In addition, the catalog lists the Wakefield commercial units designed for use with Ivanhoe, Phoenix and other glass in combination with high-powered lamps.

Breeze Manufacturing Co., 248-250 South street, Newark, N. J., manufacturer of Fle-X-Met hose, has just finished and is sending to the trade an unusually interesting 36-page catalog dealing in detail with the subject of flexible metal hose. Few catalogs have ever been issued dealing with flexible metal hose, particularly in a descriptive way. In the present book the Breeze company furnish descriptive matter covering metal hose in detail for every type and method of winding, shows how it is applied, and why, and what number of trades or industries use it. Being fully illustrated the descriptive matter is easily understood. The catalog is dedicated to engineers, mechanical superintendents, factory managers, purchasing agents and students, as it presents technical information and furnishes the solution of many puzzling engineering problems. The catalog will be mailed on request.

A. D. Straus & Co., New York City, has been appointed official representative in the United States of the Bordeaux, France, annual fair, which will be held June 5 to 20, 1920, inclusive. An opportunity is presented to manufacturers in this country to exhibit material and machinery that may be used in reconstruction work in the devastated regions of Northern France and in development work in the French colonies. Special arrangements are under negotiations with the French Line Steamship Co., whereby exhibits will be carried from New York to the Bordeaux fair and return at one-half of the tariff rates, and the French Government has authorized all foreign exhibits to be entered "in bond" for the duration of the fair, after which they may either be sold in France upon acquittal of the regular customs duties, or returned to the country of origin.

The Electrical Trade Publishing Co., 1018 South Wabash avenue, Chicago, has just issued the first number of *"The Jobber's Salesman,"* called by its publishers, "A human-interest monthly journal for wide-awake electrical salesmen." A glance through its pages gives promise that it will fill a field in the electrical industry (the training of jobbers' salesmen) that has, to a great extent, been neglected in a publication way. The first issue consists of 104 pages filled with good, readable articles, dealing mainly with selling subjects and advertising covering the same field. Articles by W. L. Goodwin, Frank B. Rae, Jr., W. E. Underwood, W. R. Herstein, D. G. Pilkington, David Gibson, W. W. Low, Jay J. Keith, Ainslie A. Gray and Charles W. Hoyt feature the first number. In the foreword Howard Ehrlich, editorial director, briefly tells all about the new magazine in a paraphrase of Lincoln's famous statement by stating, "It is a magazine of the salesmen, by the salesmen and for the salesmen—and nothing else." The new magazine is well printed and carries a large number of interesting illustrations and news pictures. It will be published monthly by the Electrical Trade Publishing Co., of which Howard Ehrlich is president, Charles W. Forbrich, vice-president and treasurer and Frank A. Merkel, secretary and general manager. All of the above men were for several years connected with the *Electrical Review,* leaving near the first of the present year to take up the new work. In this they have the best wishes and the co-operation of their former employers and associates.

PERSONAL MENTION

Biographical Sketches and Chronicle of Changes in Business Connections, Promotions and Other Personal News of the Industry

E. DONALD TOLLES has been appointed executive secretary of the Electric Hoist Manufacturers' Association, 52 Broadway, New York.

HENRY MACDONALD, president of the Public Service Corp. of Long Island, N. Y., has been elected a director of the Associated Welding Companies, Inc., New York.

C. B. READE, New York, formerly business manager of the Nassau Light & Power Co., has become a member of the firm of Hayes, Read & Co., investment securities, New York.

ARTHUR W. THOMPSON, president of the Philadelphia Electric Co., Philadelphia, Pa., gave an address at the monthly meeting and dinner of the Pittsburgh Economic club, held at the Hotel Henry, Pittsburgh, recently.

GEORGE V. MCMAHAN, for 10 years assistant general manager at Anderson, Ind., of the Remy Electric Division of the General Electric Co., has resigned to join the Anchor Engineering Co., now organizing at Anderson.

W. E. G. MITCHELL, vice-president of the Mitchell-Rand Mfg. Co., New York, manufacturer of electrical insulating materials, has left for Sarasota, Fla., to be absent for about a month. He is accompanied by his family.

CLIFFORD ARRICK has resigned from the executive forces of the Chicago Telephone Co. to accept a position

Clifford Arrick.

as vice-president of the National City Bank of Chicago. Mr. Arrick was in charge of the publicity department of the telephone company for several years.

SENATOR W. E. BOWERS, of New Haven, Ind., was elected president of the Northeastern Indiana Telephone Association at the recent annual meeting, held in Fort Wayne, Ind.

GEORGE CLARK, Lebanon, N. J., has been elected president of the New Jersey Telephone Co. Alonzo P. Greene, Chester, is vice-president; Hartwell Shepherd, Easton, is secretary, and Oliver A. Farley, Lebanon, treasurer.

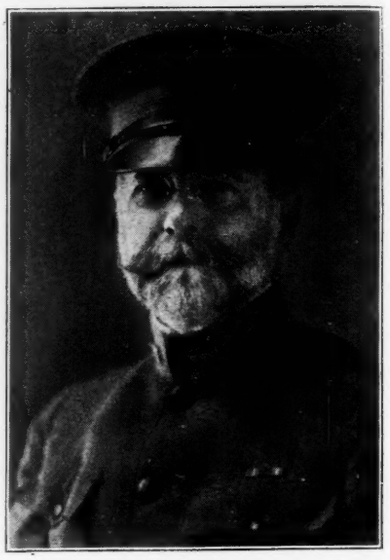
WALTER D. MYERS, sales engineer of the Louisville Gas & Electric Co., Louisville, Ky., presented an address on "Electricity—Its Development and Operating Cost in Stone Quarry Operation" at the recent convention of the National Crushed Stone Association.

FRANK L. DRIVER, president of the Driver-Harris Co., Harrison, N. J., manufacturer of insulated wire products, was the guest of honor at a dinner at Achtel-Stetter's, Newark, N. J., February 19, attended by 67 officers and employes of the company. Mr. Driver will sail for a two months' visit to England and France on March 6.

BARTON R. SHOVER, consulting electrical and steam engineer of Pittsburgh, addressed the regular monthly meeting of the Engineers' Club of the Youngstown (O.) district, Feb. 24, on "Making Steel in India." He erected one of the first plants in India, and also is designing and will superintend the erection of the plant of the Electric Steel Alloy Co., at Youngstown.

W. D. MYERS, for the past four years auditor of the Brier Hill Steel Co., Youngstown, O., has been elected treasurer of the Electric Steel Alloy Co., Youngstown, and assumed his new duties March 1. He will be succeeded at the Brier Hill company by J. V. SCHROCK, who has been chief clerk of the Carnegie Steel Co., in the Youngstown district.

MAJOR WILLIAM JOSEPH HAMMER, elected president of the Edison Pioneers at the annual meeting held at West Orange on February 11, the 73rd anniversary of Mr. Edison's birth, was connected with the Edison enterprises from 1878 to 1890, when he opened an office as a consulting engineer in New York City, which he still maintains. During his early days with Mr. Edison Major Hammer devoted himself mainly to the incandescent electric lamp, then in its infancy. He aided in preparing the original plans for the underground conductor system of the Pearl street station of the New York Edison Co., the first of its kind established in this country. In 1881 he was sent abroad by Mr. Edison and became chief engineer of the English Edison Electric Light Co. Following this he went to Berlin, where he had charge of the organization of the German Edison Co. and while there invented and built the first automatic motor-driven flashing electric sign. Returning to the United States in 1884 Major Hammer took charge of the Edison exhibits at the International Electrical Exposition, held in Philadelphia that year, and in that same year with Edward H. Johnson and Frank J. Sprague became one of the incorporators



Major William J. Hammer.

of the Sprague Electric Railway & Motor Co. During the next few years he was engaged in expert work for the Edison companies and in 1889 went to the Paris Exposition as Mr. Edison's personal representative. Major Hammer received his commission as major in the U. S. Army on June 4, 1918, and was appointed a member of the Inventions Section, War Plans Division of the General Staff at the Army War College, Washington, D. C. On Dec. 13, 1918, by direction of President Wilson he was made a member of the General Staff Corps and in that capacity had charge of the various electrical and aeronautical inventions submitted to the government during the world war. He is a fellow and a life member of the American Institute of Electrical Engineers and a member of the New York Electrical Society, having been vice-president of both organizations. He is also a fellow of the American Association for the Advancement of Science and member of many other organizations.

OBITUARY.

JOHN A. RANDOLPH, for a number of years connected with the Westinghouse Electric & Manufacturing Co., as a technical writer, died on Jan. 30 last, at Columbia hospital, Wilkinsburg, Pa., of pneumonia. Mr. Randolph was graduated from Syracuse University with the class of 1903 and after graduating engaged in engineering and in writing technical literature for trade magazines, later joining the Westinghouse forces. He was also engaged for a time in the activities of the Society for Electrical Development, New York City.

BUSINESS OPPORTUNITIES

News of Electrical Construction Projects in All Parts of the Country, Proposals Invited, Foreign Trade Openings and New Companies

EASTERN STATES.

Mt. Desert Island, Me.—United States Government, Bureau of Yards and Docks, has had plans prepared for the construction of a new transmission station (Specification 4133) at its local site. The structure is estimated to cost about $20,000.

Fair Haven, Vt.—Mahar brothers have recently broken ground for the construction of a new local granular slate mill, to be operated throughout by electric energy. Power, of which about 800 hp. will be required, will be furnished by the Vermont Hydro-Electric Corp.

Rutland, Vt.—In a report recently issued by the Rutland Railway, Light & Power Co., it is set forth that during the year 1919 a total of 480 lighting customers were connected to the lines of the company, as well as 1159 hp.

Chelsea, Mass.—Winnisimmet Ship Yard, Inc., Winnisimmet street, has practically completed the erection of the new power plant at Williams and Pearl streets, and it is expected to inaugurate operations at an early date. The extension is estimated to cost $20,000.

Fall River, Mass. — King Philip mills, 372 Kilburn street, has inaugurated work on the construction of a new addition to its boiler plant, for increased power facilities. The structure will be 2-story, brick, about 48 by 80 ft., and is estimated to cost $50,000. The McNally Construction Co., 86 North Main street, Fall River, is the building contractor.

Lowell, Mass.—Lowell Gas Light Co., School street, has awarded a contract to Warwick & Hurley, Appleton street, for the erection of a new addition to its boiler plant, as well as alterations and improvements in the existing structure. The work is estimated to cost about $60,000.

Taunton, Mass.—General Electric Co., Lynn, has completed foundations for the construction of its proposed new 1-story brick plant, about 89 by 206 ft., to be located in the Weir village district. The company has also awarded a contract to the William M. Bailey Co., 88 Broad street, Boston, Mass., for the erection of the proposed addition to its plant at Windsor, Conn., brick and concrete construction, estimated to cost about $75,000. It is understood that the new addition will practically double the output of this plant.

Bridgeport, Conn.—Barnum Electric Co. has filed notice of organization to operate at 967 Hancock avenue in a general electrical contracting capacity, etc. W. A. Maguire and Adam Spaner head the company.

Hartford, Conn.—Hartford City Gas Light Co. has awarded the contract to Connor & Poriss, Inc., 54 Church street, Hartford, for the construction of the proposed new 1-story addition to its power plant. The structure will be of brick and concrete construction, about 40 by 45 ft.

Buffalo, N. Y.—Philadelphia Rubber works, Akron, Ohio, is understood to be having plans prepared for the construction of a new group of buildings at Buffalo, N. Y., to comprise two manufacturing structures, administration building, power plant for general works operation, and garage for company cars. The proposed new plant will be located on the Niagara river, and when completed is estimated to cost close to $1,000,000, including machinery and equipment installation. The Austin Co., Euclid avenue, Cleveland, O., is engineer for the company.

Highland, N. Y.—Acme Storage Battery Corp., manufacturers of storage batteries, etc., has filed notice with the Secretary of State of an increase in its capital from $100,000 to $175,000 to provide for general business expansion.

Long Island City, N. Y.—Astoria Light, Heat & Power Co., 130 East 15th street, New York City, has awarded a contract to the George A. Fuller Co., 949 Broadway, for the construction of the proposed new local gas generator plant, at Van Alst & Winthrop avenues. The structure will be 2-story, about 60 by 362 ft., and it is proposed to inaugurate construction work at once. The plant, with equipment, will cost about $150,000.

New York, N. Y.—Knickerbocker Ice Co., 1480 Broadway, has inaugurated construction work on its proposed new one and 3-story ice manufacturing plant, about 60 by 200 ft., to be located on Willis avenue, near Old Counter road, Mineola, L. I. Considerable electrical machinery and refrigerating apparatus will be required in connection with the work.

New York, N. Y.—New England Incandescent Supply Co., 266 Bowery, has completed arrangements for the leasing of the building at 258 Elizabeth street, to be used for increased operations.

New York, N. Y.—Columbia X-Ray & Electric Corp., 131 East 23rd street, has filed notice with the Secretary of State of an increase in its capital stock from $20,000 to $40,000, to provide for general business expansion.

New York, N. Y.—Announcement has been made by All America Cables, 89 Broad street, that work has been completed on the laying of cable from Santos to Montevideo. The company has also inaugurated work on the laying of cable line from Montevideo to Rio de Janeiro, Brazil, and it is planned to establish communication about March 20.

New York, N. Y.—Following the recent strike of a number of telephone operators in various exchanges, the New York Telephone Co. has announced that the present wage scale is to be adjusted at a conference between management and representatives of the employes. Pending the settlement of the wage question work was resumed by the striking employes.

New York, N. Y.—Manhattan Electric Supply Co., 17 Park place, has completed negotiations for the leasing of property at 423 Broome street, at which location the entire building will be occupied, for a term of 10 years.

Niagara Falls, N. Y.—United States Light & Heat Corp., 3215 Highland avenue, manufacturer of electric batteries, etc., is having plans prepared for the construction of a new 2-story brick addition to its plant, for increased operations. The structure will be about 80 by 100 ft. Mills, Rhines, Bellman & Nordoff, Ohio building, Toledo, O., are engineers.

Rochester, N. Y.—Effective March 16, the Rochester Gas & Electric Corp. will make operative new schedules of rates for service covering Rochester, East Rochester, Pittsford and other municipalities in Monroe county. The increases will cover two charge rates for light and power service, three charge rates for d.-c. light and power service, and three-charge rates for a-c. light and power service, as well as changes in regulations governing service connections during the winter period.

Rochester, N. Y.—Preliminary steps have been taken for the consolidation of the telephone systems of the New York Telephone Co. and the Rochester Telephone Co., the new company to be known as the Rochester Telephone Corp. A certificate of incorporation has been filed with the Secretary of State placing the capitalization at $7,000,000. It is proposed to commence work at once on the construction of trunk lines to connect the exchanges of the two companies.

Sodus, N. Y.—Application has been filed with the Public Service Commission, Albany, by the Wayne Power Co., for permission to make extensions and improvements in its electric transmission system, as well as the installation of a quantity of new equipment to increase its present service. The transmission line will be extended for about four and one-half miles, and the entire expansion work is estimated to cost $91,500. The company proposes to issue bonds for this amount, the proceeds to be used to cover the cost of the work.

Syracuse, N. Y.—Dyneto Electric Co., 301 Wolf street, manufacturer of electric starting and lighting systems for automobiles, etc., is considering plans for the erection of a new fac-

tory and office building to be located at Park and Wolf streets, to provide for increased operations. Ford, Bacon & Davis, 115 Broadway, New York City, are engineers for the company.

Bayonne, N. J.—Board of Managers of the Bayonne hospital, East 30th street, has completed foundations in connection with the construction of new additions to the institution, including power plant and laundry building. The extensions are estimated to cost about $250,000, and considerable electrical and mechanical equipment will be required. The Franklin Rocks Co., 354 West 24th street, New York, is the contractor.

Camden, N. J.—It is interesting to note that a total of aproximately 95 per cent of the lines of the Delaware & Atlantic Telephone & Telegraph Co. have been placed underground replacing the former overhead wire system.

Elizabeth, N. J.—Consumers Ice & Cold Storage Co., 1079 East Grand street, has awarded a contract to H. Wilhelms & Son, 803 East Jersey street, Elizabeth, for the construction of the proposed new addition to its local ice manufacturing plant for increased capacity. The structure will be 2-story, about 50 by 150 ft., and is estimated to cost $46,000, including machinery and equipment installation.

Hoboken, N. J.—Bijur Motor Appliance Co., 15th street, manufacturer of starting and lighting systems for automobiles, and other electric appliances, a Delaware corporation, has filed notice with the Secretary of State of an increase in its capitalization from $1,812,500 to $2,312,500, to provide for general business expansion.

Keyport, N. J.—Monmouth Lighting Co. is understood to be considering plans for extensions and improvements in its power station at Keyport, for increased service. The new work includes the installation of a turbine unit, as well as improvements in the condenser equipment, and auxiliary apparatus.

Newark, N. J.—Plans have been completed by the Murray Motor Car Co., 19 West 44th street, New York, for the construction of a new 1-story brick and steel power plant, to be used for the operation of its proposed new local plant. The new works will comprise a total of four factory buildings, located at Frelinghuysen avenue and McClellan street, and are estimated to cost close to $400,000. It is understood that large quantities of electrical and mechanical equipment will be required. Henry Y. Rosensohn, 800 Broad street, Newark, is architect.

Newark, N. J.—In connection with the recent severe storms in the eastern section of the country, it is interesting to note that a total of about $300,000 was required by the Public Service Railway Co., above the normal operating charges to supply the state with trolley service during this period. This sum includes labor for the removal of snow, as well as repairs to the mechanical equipment of the rolling stock, a large number of motors being damaged.

Newark, N. J.—Kab Electric Service Co. has filed notice of organization to operate at 142 Market street in a general electrical contracting capacity. Michael and Harry E. Kabcenel head the company.

Newark, N. J.—Modern Electric Co. has filed notice of organization to operate at 518 South 19th street for the production of electrical goods. Abraham Zacker, 486 South 13th street, heads the company.

Pleasantville, N. J.—Board of Public Utility Commissioners has approved the sale of the Pleasantville & Shore Electric Co., capitalized at $100,000, to the Atlantic City Electric Co., Atlantic City, N. J.

South Amboy, N. J.—Common Council is arranging plans for improvements in the electric street-lighting system, electric energy for the operation of which is furnished by the Monmouth Lighting Co.

Summit, N. J.—Board of Public Utility Commissioners has authorized the Commonwealth Electric Co. to place into effect a new schedule of rates for service, under which schedule the household appliance rate will be increased by about one-half a cent per kw-hr., the power rates will be revised to effect a similar increase, and new standard and private lighting rates will be established.

Trenton, N. J.—National Porcelain Co., Southard street, manufacturer of electrical 'porcelain specialties, has had plans prepared for the construction of a new 2-story addition to its plant, for increased output. The structure will be about 50 by 72 ft., and is estimated to cost $20,000.

Whitehouse, N. J.—Township Commissioners have approved an appropriation of $5000 to be used for the installation and operation of a municipal electric street-lighting system. In this district three other municipalities have approved appropriations to be used for this purpose, these being, Annandale, Lebanon, and Oldwick.

Bethlehem, Pa.—Fritch Coal Co. is considering plans for the installation of electric apparatus at its Stahr yards, to be used for the loading of coal. It is proposed to increase the capacity approximately to 20,000 tons.

Easton, Pa.—Pennsylvania Pump & Compressor Co., recently organized with a capital of $500,000 by a number of prominent local interests, is having plans prepared for the construction of a large new plant for the manufacture of hydraulic pumping machinery, air compressors, and allied specialties. The company has completed negotiations for the acquirement of property at Bushkill park, near Easton, aggregating about 55 acres, as a site for the proposed plant; the initial plant unit will be of brick and steel construction, and it is proposed to have the factory ready for operation early in the summer.

Easton, Pa.—Pennsylvania Utilities Co. has recently completed work on the rebuilding of the switchboard at its Dock street plant, to facilitate operations. The company has been awarded a number of contracts for the furnishing of electric energy for industrial-plant service, among which are the Easton Car & Construction Co., the Treadwell Engineering Co., the Simon Silk mills, and others. These companies have been erecting new additions at their various plants for increased operations, requiring additional power service.

Harrisburg, Pa.—Red Lion Telephone Co. has filed notice with the Secretary of State of an increase in its capital stock from $40,000 to $140,000, to provide for general business expansion.

Pittsburgh, Pa.—Oil Well Supply Co. has been granted permission to construct a waterworks intake pier on the Allegheny river, near 21st street.

Philadelphia, Pa.—Department of Public Works, is having plans prepared for the construction of a new ash handling plant, to be located at the Torresdale municipal pumping station, Torresdale, Pa. The installation is estimated to cost about $50,000. John C. Winsted is director of the department.

Philadelphia, Pa.—Daniel Adams, 2934 North Marshall street, has taken out a building permit for the construction of a new addition to the boiler plant at his establishment, as well as alterations and improvements in the existing structure.

Philadelphia, Pa.—Moore Pushpin Co., 137 Berkley street, has had plans prepared for the erection of a new 1-story brick addition to its boiler plant, to provide increased power facilities.

Pittsburgh, Pa.—Electrical Engineering Co., 7 West Canal street, Northside district, is operating its local plant at capacity for the production of switchboards for power-plant service. The company is one of the city's newest industries, and a large plant is operated.

Baltimore, Md.—Bethlehem Steel Corp. is having plans prepared for extensive additions and improvements at its Sparrows Point, Baltimore, works. The structures will include large power plant for general works operations, sheet metal shop, pipe shop, joiner shop, as well as auxiliary structures, and will provide employment for about 1,000 additional persons. Considerable electrical and mechanical equipment will also be required in connection with the expansion.

Dundalk, Md.—Consolidated Gas, Electric Light & Power Co., Lexington building, Baltimore, is having plans prepared for the construction of a large new electric power station to be located in the vicinity of Dundalk, near Baltimore, for increased power service. It is understood that the project will include the erection of a total of about three units.

Emmittsburg, Md.—Board of Managers of Mt. St. Mary's College is having plans prepared for the construction of a new 1-story steam-operated electric power plant at the institution. The structure is estimated to cost about $25,000. Frank J. Baldwin, 328 North Charles street, Baltimore, is architect.

Petersburg, Va.—Considerable electrical equipment, including motors for individual drive, will be required by the Petersburg Silk Hosiery Corp.,

recently incorporated with a capital of $500,000 to operate a local plant for the manufacture of silk hosiery. It is proposed to have a daily capacity of about 1800 dozen pairs of hose. Edwin S. Bayer is president and Arthur G. King treasurer.

Richmond, Va.—Appalachian Power Co. has filed notice with the Secretary of State of an increase in its capitalization from $8,050,000 to $12,000,000 to provide for general business expansion.

Edenton, N. C.—City is planning the issuance of bonds for $25,000, the proceeds to be used for improvements in the municipal electric system. J. L. Martin is superintendent.

Walterboro, S. C.—Walterboro Public Service Commission is having plans prepared for the installation of new equipment in the municipal power plant. It is also understood that plans are under consideration for improvements and extensions in the plant, for increased capacity.

Reynolds, Ga.—City is arranging plans for the construction of a new municipal electric light plant. It is proposed to issue bonds for $15,000, to cover the cost of the proposed work.

Smithville, Ga.—City is having plans prepared for the installation of a new municipal electric light plant and water system. J. B. McCrary Co., Citizens' and Southern Bank Building, Atlanta, Ga., is engineer. J. H. Randall, Jr., is mayor.

Woodberry, Ga.—City is having plans prepared for improvements and extensions in the municipal electric lighting system. The work is estimated to cost $15,000. J. B. McCrary Co., Citizens' and Southern Bank Building, Atlanta, is engineer.

NORTH CENTRAL STATES.

Cincinnati, O.—Standard Electric Tool Co. has increased its capital stock from $40,000 to $75,000. It is understood new equipment will be purchased to increase its production of electric drills and grinders.

Warren, O.—Packard Electric Co. is understood to be arranging plans for the erection of a large new plant to be devoted to the production of transformers as well as electric equipment for automobile service. The company has recently filed notice of an increase in its capital to $1,500,000, to provide for the proposed expansion.

Columbia City, Ind.—The Columbia Iron works has increased its capital stock from $20,000 to $75,000.

Evansville, Ind.—Sunbeam Electric Manufacturing Co. has increased its capital stock to $275,000.

Richmond, Ind.—The Loraine Car Co. has increased its capital stock from $100,000 to $350,000.

South Bend, Ind.—The Indiana and Michigan Electric Co. has increased its capital stock from $5,000,000 to $11,500,000.

Chicago, Ill.—Devry Corp., 1248 Marianna street, manufacturers of moving picture machines, has let a contract for the construction of a 3-story plant, 83 by 100 ft. at 3507 North Racine avenue, Chicago, to cost $90,000.

Chicago, Ill.—H. Kramer & Co., 1224 West 21st street, smelters, have awarded contracts for the construction of a 1-story foundry, 127 by 200 ft., 2-story warehouse, 30 by 85 ft. and a 2-story office building, 58 by 65 ft. at 21st and Loomis streets at a cost of $150,000.

Elgin, Ill.—The plant of the William A. Field Tool Manufacturing Co. was damaged by fire to the extent of $90,000.

Peoria, Ill.—The Peoria Malleable Castings Co. has certified to an increase of capital stock from $175,000 to $250,000, the increased capitalization to be used in the enlargement of the plant. Several new welding furnaces and ovens will be built.

Detroit, Mich.—Morgan & Wright Co., tire manufacturer, subsidiary of U. S. Rubber Co., has taken out a building permit for a $1,000,000 power plant.

St. Johns, Mich.—Industrial foundry is about to increase its capitalization to $150,000 to care for expanding business and provide for necessary additions and improvements.

Milwaukee, Wis.—Milwaukee Electric Crane & Manufacturing Co. has the contract for three 10-ton cranes for the new turbine shops of the Westinghouse Electric & Manufacturing Co. at Lester, Pa. A 30-ton crane with a 5-ton auxiliary hoist, and a 70-ft. span, will be furnished by the Hooven, Owens, Rentschler Co., Hamilton, O.

St. Francis, Wis.—Contract for the first unit of the Lakeside power plant of the Electric Co. has been let to the National Bridge & Iron Co., Milwaukee, Wis. The contract calls for 1500 tons of structural shapes. The unit will cost $500,000 and the complete plant about $7,000,000.

Davenport, Iowa.—B. L. Schmidt Co., manufacturers of gasoline engines and appliances, will erect a foundry and machine shop at an expenditure of $80,000.

Mountain Grove, Mo.—With the increase in the capital stock of the Mountain Grove Light and Power Co. to $300,000 for the construction of a dam, power plant and transmission lines, the towns of Mountain Grove, Willow Springs, Cabool, Mansfield and Gainesville will be supplied with hydroelectric power. The dam and power plant will be constructed at Double Springs, 22 miles west of West Plains, in Ozark county.

Richland, Mo.—Richland Light & Power Co. will install 60 kw. three-phase, 60-cycle, 2300 volt alternators, fuel oil engine, ice-plant equipment and other machinery.

SOUTH CENTRAL STATES.

Harlan, Ky.—The Bowen Foundry, Machine & Electrical Co. has increased its capital stock from $20,000 to $50,000 and is planning additions to its plant.

Louisville, Ky.—Peerless Manufacturing Co., recently reorganized, is remodeling its power and heating equipment and installing new motors.

Manchester, Ky.—The Columbia-Panama Coal Co., 840 State-Lake building, Chicago, Ill., will equip a power plant and make purchases for coal mining operations at Manchester.

Senatobia, Miss.—Plans are being arranged by the city for extensions and improvements in the electric light and water systems, for increased operations. It is proposed to issue bonds for $10,000, the proceeds to provide for the cost of the work. T. M. Gregory is mayor.

Shaw, Miss.—City Council is planning for a bond issue of $30,000, the proceeds to be used for improvements and extensions in the municipal electric light and water systems. J. W. Bishop is mayor.

Boyce, La.—City has approved the issuance of bonds for $30,000, the proceeds to be used for improvements in the municipal electric light and water systems. Xavier A. Kramer, Magnolia, Miss., is consulting engineer; A. M. Dean is mayor.

New Orleans, La.—New Orleans Railway & Light Co. has had plans prepared for the installation of a quantity of new equipment in its electric power plant, for increased operations. The work includes the installation of new 15,000 kw. turbine unit, condenser, pumping equipment, piping, fuel oil storage tank of 30,000 gallons capacity, and auxiliary apparatus. John S. Bleecker is general manager.

Abilene, Tex.—Abilene Gas & Electric Co. has completed plans for the erection of a new generating plant to cost about $100,000.

Brownwood, Tex. — There is considerable agitation for the building of an interurban road from May to Rising Sun, a distance of nine miles, connecting with the Brownwood, North & South railway, at May. This road was built several years ago by Brownwood capital. The plans discussed involved the eventual extension of the road to Cisco.

Eastland, Tex.—Oil Belt Power Co. is arranging plans for the erection of a large new power plant on the Leon river, with transmission and distributing system throughout this district. The proposed plant will be of steel and concrete construction, about 90 by 90 ft., with equipment installation to include two 3,000 kw. steam turbines, boilers, condensers, etc. The plans include the erection of a large dam across the Leon river for water supply for the hydroelectric end of the development. The project is estimated to cost over $1,000,000.

Houston, Texas.—The Lucey Manufacturing Co., Mason building, will build a foundry, machine shop and forge shop, to cost $1,000,000.

Sweetwater, Tex.—Armstrong Farm Tractor Co. is having plans prepared for a tractor plant costing $130,000, with equipment, the first unit being 100 by 200 ft.

WESTERN STATES.

Helena, Mont.—Chase Engineering Co. is opening a new distributing house for the Montana territory at 11 Placer avenue. The company will

handle electrical supplies for automobiles.

Bremerton, Wash.—Swensson & Co., Seattle, have been awarded a contract for building an extension to the power plant at the Navy yard, estimated to cost $50,000.

Seattle, Wash.—Bids will be opened March 16 by the comptroller of the University of Washington for an engine-driven generating unit in the university power house.

Chino, Cal.—A large boiler plant will be constructed by Libby, McNeil & Libby in connection with the erection of additions to their local fruit packing plant, to cost about $50,000.

Los Angeles, Cal.—Southern Counties Gas Co., 724 South Spring street, has increased its bonded indebtedness from $10,500,000 to $12,000,000, the proceeds to be used for proposed extensions and improvements.

Los Angeles, Cal.—Southern California Telephone Co. has completed plans for the construction of a 3-story and basement brick addition to its substation on Rampart street, near 7th street, estimated to cost about $30,000. The company's engineering department is in charge of the work.

CANADA.

Edmonton, Alta.—Premier Stewart has announced, according to newspaper report, that an appropriation of more than $4,000,000 for telephone extensions will be asked for at the coming session of the legislature. This is to provide better facilities in the outlying districts of the province.

Gloucester, Ont. — Council has approved the installation of a hydro-electric system for both light and power. This will involve an expenditure of approximately $100,000. As soon as the approval of the Hydro-electric Commission has been received the construction of the lines will be announced.

Kitchener, Ont.—In order to meet the extraordinary shortage of power, it is said the Kitchener Light Commission has under consideration the installation of an auxiliary plant. A special engineer is to be called in to look over the ground.

London, Ont. — It has been announced by Supt. Williams, of the Canadian Pacific railway, that an automatic electric-light system of signals is to be installed this summer on 125 miles of track between London and Toronto. Altogether, $250,000 will be spent by the company in improvements in this division during the summer of 1920.

Peterboro, Ont. — The Canadian General Electric Co. is prepared to expend in Peterboro, on new buildings and equipment between $600,000 and $1,000,000. Work on the new buildings is to commence in June, and will include a molding shop.

Sherbrooke, Que.—City proposes to spend $300,000 on extension of city electric plants.

Toronto, Ont. — Famous Players Canadian Corp., 208 Victoria street, is planning the erection of theaters in Halifax, N. S., Kitchener, Ont., Montreal, Que., Oshawa, Ont., Ottawa, Ont., Quebec, Que., and St. Johns, N. B. About $2,000,000 is involved in the construction of the buildings, exclusive of equipment. N. L. Nathanson, Temple building, Toronto, Ont., is managing director.

INCORPORATIONS

Menard, Tex.—Menard Light and Ice Co. has been incorporated with capital stock of $30,000. Incorporators are A. E. Nauwald, Peter Anderegg and W. M. Bevans.

Crothersville, Ind. — Crothersville Water and Electric Co. has been incorporated with capital of $50,000 by W. P. Rider, C. W. Keach and H. B. White.

Indianapolis, Ind.—Apex Manufacturing Co. has been incorporated with capital of $10,000 for the manufacture of machinery. The incorporators are John Murphey, George Shepherd and F. J. Montani.

Kokomo, Ind.—The Lava Metal Co. has been incorporated with capital of $20,000 by Ollie H. Buck, David C. Jenkins and L. B. Hodgie.

Bristow, Okla.—Bristow Machine & Boiler Co. has been incorporated with capital stock of $50,000. C. Ross Anthony, A. L. McClaskey and William Shoefstall, all of Cleveland, Okla., are incorporators.

Morris, Okla.—Great Western Electric Co. has been incorporated with capital stock of $250,000. C. J. Rogers, W. A. Wilson and H. G. Toomer are incorporators.

New York, N. Y.—Continental Lamp works. Capital $20,000. To manufacture incandescent lamps. Incorporators: L. Demeter, T. P. Vilaghy and I. J. Lynch, 574 West 192nd street.

New 'York, N. Y.—Non-Vacuum Electrode Co. Capital, $50,000. To manufacture electrodes. Incorporators: H. J. Sondheim, M. B. Cohn, and H. A. Cohn, 51 Chambers street.

New York, N. Y.—Hampton Engineering Co. Capital, $15,000. To manufacture motors, engines, etc. Incorporators: L. C. Cocheu, S. S. and S. F. Hampton, 6 Wall street.

Utica, N. Y.—Utica Electric Sun Signs, Inc. Capital, $36,000. To manufacture electric signs. Incorporators: A. J. Haight, A. Klebs, and W. B. Marstors.

Hackensack, N. J.—Atmo Signal Corp. Capital, $200,000. To manufacture electrically-operated signal systems. Incorporators: Wendell J. Wright, LeRoy Van Derburgh, and Selma Salmansohn.

Newark, N. J.—Beller Electric Supply Co. Capital, $100,000. To manufacture electrical goods. Incorporators: Robert and B. H. Beller, and Abraham Cohen.

Holyoke, Mass.—Burr Appliance Co. Capital, $250,000. To manufacture electrical appliances. Incorporators: Charles D. Heywood and Russell L. Davenport, Holyoke; and Charles F. Munder, Springfield, Mass.

Wilmington, Del.—Independent Light & Power Co. Capital, $250,000. To operate electric light and power plants. Incorporators: M. C. Kelly, M. L. Horty and S. L. Mackey.

Wilmington, Del.—Bolivian Power & Light Co. Capital, $2,000,000. To operate electric power plants and transmission systems. Incorporators: L. A. Irwin, M. L. Rogers and W. G. Singer.

Holtwood, Pa.—Martic-Drumore Electric Light, Heat & Power Co. Capital, $15,000. To operate a local light and power system. Incorporators: Robert H. Long, Drumore, and associates.

Baltimore, Md.—King Electric Washing Machine Co. Capital $100,000. To manufacture electrically-operated washing machinery. Incorporators: Charles L. Houck, William J. Baeschke and Charles C. Schaefer.

Marianna, Ark.—People's Electric Co. Capital $50,000. To operate a local light and power system. Incorporators: M. D. Miller and D. G. Norment.

FOREIGN TRADE

[Addresses of firms referred to in these trade opportunities may be obtained by writing to the Bureau of Foreign and Domestic Commerce, Washington, D. C., or its branch and local co-operative offices. Request for each opportunity should be on a separate sheet and the file number given.]

Motors (31,859)—A company in England desires to purchase motors for use in the construction of electric vehicles, in quantities of from 5 to 20 per week, sizes 4, 6, and 8 hp., and voltage for either sizes of 88 for lead batteries, and 60 for Edison batteries. The motors to be in every way suitable for traction purposes, and to be capable of giving three times the normal torque at one-half speed for 10 min. and to have the highest possible efficiency from half load to 200% overload, fitted with ball bearings and totally enclosed. Quotations should be given c. i. f. English port. Reference.

Electrical Goods (31,863)—A commercial agent from Italy is in the United States for a short time and desires to secure an agency for the sale of electrical goods and supplies, automobiles, and motor accessories from manufacturers only. References.

Wire and Cable (31,864)—The electrical department of a machinery and supply company in Mexico desires to receive information as to base prices of wire and cable, with discount, and the added amounts for size, stranding, insulation reels, etc., as per specifications which may be secured upon request for this opportunity number. References.

Electrical Machinery and Appliances (31,990)—An electrical lighting company in a city of Chili desires to purchase electric machinery and appliances. Plans may be secured upon application to this company, through Foreign Trade Bureau, Washington, D. C.

For the Readjustment Period—What?

Where Trade and Technical Journals Help

THIS is not a bid for subscriptions, although some suspicious-minded individual may think so, but a plea for a greater appreciation of the trade magazine generally, whether the magazine has printing for its field, or railroading, or the making of textiles or tools. To one who watches, it seems incredible that a large part of the brains of modern business will not make the effort to keep informed with regard to the news and advance in a particular line of work. These are days when conditions are changing as never before, except, perhaps, with the introduction of steam as a motive force; when new devices are constantly being invented; when prices will hardly hold overnight; and yet many a man at the head of his business depends entirely on what he learns by word of mouth from his associates or his competitors, rather than from a trade journal, which must, of necessity, keep its ear to the ground and report promptly all change and progress.

That there is a growing feeling that this is not the right attitude for a man or a concern that wishes to grow is shown by the change which is coming over a few managements, and which is sure to have so much influence that it will gradually force a general interest in affairs of the trades. Two printers' supply firms, at least, have made the start by instructing all members of their sales forces to read all of the journals of the printing trade carefully, and by offering prizes each month for the best ideas which may be obtained which may be best adapted to their businesses. This plan, however, should not be limited to the salesmen, but it should apply in a manufacturing business to the manufacturing, accounting, and executive branches as well, for the well-edited trade journal does not consider one single corner of the trade alone, but from its desire to interest, if for no other reason, it must handle the affairs of all departments. As a consequence, any careful reader, or as a matter of fact anyone who merely glances through its pages is very likely to find an idea, or a suggestion, or a bit of news which can be put to good use, or which may be made to save both time and money.

Sometime, as you let the lid of your desk roll noisily down at the end of the day, pick the last number of your trade journal off the pile on top of the desk, take it home, and when you have absorbed the news from the evening paper, go through it carefully. Don't look at the illustrations alone, and then run over the display lines in the advertisements, but begin with the text; read the first thing that looks interesting, and then go on. It is safe to say that you will. Then you will begin to find yourself thinking of something you have read, and the first thing you know, you believe that you can do this or that in your own business. It is the use of other men's ideas that will keep you from getting in a rut.

Get the habit of reading your trade journals yourself. It is worth while. Then boost them among your employes. Send in two or more subscriptions, so there will be enough copies to go around before they get stale. It will be money well spent. Offer prizes for ideas that can be put to service in your business, or suggestions that will bring in more orders. Keep up with the times yourself, and carry your men with you.

This editorial from the "Printing Art" is worth thinking over. How does it hit you?

C. A. TUPPER - - - President
INTERNATIONAL TRADE PRESS, Inc., Chicago

FINANCIAL NEWS

Comment on the Financial Outlook in the Electrical Industry, New Securities, Reports of Earnings, Dividends and Utility Stocks

Bell System Earned $79,650,186 During Year 1919.

That the world war, and its attendant upsetting of telephone business due to the government taking over the lines for a long period, did not materially injure the American Telephone & Telegraph Co. (Bell system) is shown by the annual report of the company for the year ended Dec. 31, 1919. The finances of the company are in an exceedingly healthy condition.

For the whole Bell system with all duplications excluded the total income, including compensation, after the deduction of expenses amounted to $79,650,186. From this over $27,000,000 was paid in interest and $39,000,000 in dividends, leaving over $12,000,000 surplus. The surplus earnings in the last five months of the year since the end of Federal control have been $7,000,000.

The capital stock, bonds and notes payable of the Bell system outstanding in the hands of the public at the close of the year were $1,060,000,000, while the net assets devoted to earning return on these outstanding securities amounted to over $1,448,500,000. This is due to the fact that surplus and reserves of over $388,500,000 had been invested in productive property.

For the American Telephone & Telegraph Co. the net earnings of the year were over $60,000,000. In round figures, the interest charges were $15,000,000, the dividends $35,000,000 and the resulting balance $9,000,000, of which $5,000,000 was appropriated to reserve for contingencies and $4,000,000 added to surplus.

Milwaukee Electric Takes Big Drop in Net Earnings.

Chicago, North Shore & Milwaukee Electric railroad reports a net income for the year ended Dec. 31, 1919, of $431,839.33, a decrease from the 1918 earnings of $103,239.59. Gross operating revenue in 1919 was $3,237,921.09, compared with $2,899,975.16 in 1918, an increase of $337,945.93.

The increase, however, is more than offset by the increase in operating expenses, which were $2,319,464.12 this year as compared with $1,856,038.25 last year, or an increase for 1919 of $463,425.87. The net operating revenue this year is $918,456.97, compared with $1,043,936.91.

Britton I. Budd, president of the road, in his annual address to stockholders attributes the increase in gross operating expense to the improvements in general business activities along the line, the growth of traffic and to good service. He adds: "The decrease in net income was caused largely by increases in cost of labor and material. Increased wages effective Aug. 1, 1919, amount to $300,000 per annum."

Laurentide Power Co.

Laurentide Power Co., Quebec, the hydraulic subsidiary of the Laurentide Company, Ltd., reports reduced earnings for 1919 as the result of which, after paying $420,000 in dividends on the capital stock at the rate of 4% per annum, there was a deficit of $136,050, and the surplus account was reduced from $162,420 to $19,806. The net earnings were $671,075, compared with $686,767 in 1918. The revenue will be increased in July next when the Laurentide and the Shawinigan take large blocks of power. This prompted the board to continue the dividend though not earned.

Interstate Co. to Sell Stock.

The Interstate Public Service Co., with offices in Indianapolis, manufacturing energy for lighting, heat and power in a number of Indiana counties, has filed a petition with the Indiana Public Service Commission for authority to sell $226,000 in par amount of its 7% prior lien stock at not less than 90% of par.

Brooklyn Edison Elects Directors.

At the annual meeting of the Brooklyn Edison Co., held Feb. 24, the following directors were elected: Frank Bailey, Charles A. Boody, James C. Brady, N. F. Brady, H. L. Bridgman, William C. Courtney, Daniel J. Creem, Horace C. Du Val, Walton Ferguson, George B. Gallagher, William V. Hester, Adrian T. Kiernan, Thomas E. Murray, M. S. Sloan, W. F. Wells.

National Conduit & Cable Co.

Annual report of the National Conduit & Cable Co., Inc., for the year ended Dec. 31, 1919, shows a deficit of $1,116,340 after taxes and all charges as compared with a deficit of $860,822 in the preceding year. The report follows:

	1919.	1918.
Sales	$10,557,836	$14,011,664
Cost of sales	10,759,471	13,059,809
Mfrg. loss	181,635	*951,855
Freight charges, general expenses	440,336	431,152
Net loss	621,970	*520,705
Other income	170,427	98,996
Balance loss	451,544	*619,700
Interest and taxes	345,073	427,612
Balance loss	796,617	*192,097
Depcn., extraord. chg.	319,723	1,052,909
Final net loss	1,116,340	860,822

*Gain.

New England Telephone & Telegraph Co.

New England Telephone & Telegraph Co.'s annual report for year ended Dec. 31, 1919, shows net available for dividends after deducting Government compensation of $2,835,124 of $5,424,934, compared with net of $5,002,719 in 1918.

United Gas & Electric Co.

Total earnings of subsidiary operating companies controlled directly through ownership or through ownership of common stock of the United Gas & Electric Co., of New Jersey, and Lancaster Railway & Light Co. for the month of January, 1920, compare with January, 1919, as follows:

	1920.	1019.
Gross	$1,122,471	$ 945,041
Net after taxes	404,853	321,591

Pacific Telephone Co.

The Pacific Telephone & Telegraph Co., San Francisco, reports to the Interstate Commerce Commission for December:

December—	1919.	Decrease.
Operating revenue	$2,155,593	$ 344,507
Operating income	308,645	224,461
Jan. 1 to Dec. 31—		
Operating revenue	24,956,473	3,473,820
Operating income	4,241,003	368,577

Dividends.

American Telegraph & Cable Co. declared the regular quarterly dividend of 1¼%, payable March 1 to stockholders of record Feb. 28.

Washington (D. C.) Railway & Electric Co. has passed its semi-annual dividend of 2½% on the preferred stock. President William F. Ham says the dividend is not being earned because of insufficient rates. The dividend is cumulative.

Galveston-Houston Electric Co. has declared its regular semi-annual dividend of $3 a share on the preferred stock, payable March 15 to stockholders of record March 5.

WEEKLY COMPARISON OF CLOSING-BID PRICES OF SECURITIES OF LEADING ELECTRICAL COMPANIES.

Quotations furnished by F. M. Zeller & Co., Rookery Bldg., Chicago.

Public Utilities.	Div. rate. Per cent	Bid Feb. 24.	Bid Mar. 2.
Adirondack Electric Power of Glens Falls, common	6	13	11
Adirondack Electric Power of Glens Falls, preferred	6	76	76
American Gas & Electric of New York, common	10+extra	121	120
American Gas & Electric of New York, preferred	6	39¼	38
American Light & Traction of New York, common	..	190	183
American Light & Traction of New York, preferred	6	88	88
American Power & Light of New York, common	4	59	57
American Power & Light of New York, preferred	6	71	68
American Public Utilities of Grand Rapids, common	..	3	3
American Public Utilities of Grand Rapids, preferred	7	18	18
American Telephone & Telegraph of New York	..	97½	97⅜
American Water Works & Elec. of New York, common	..	2	2
American Water Works & Elec. of New York, particip	7	4	7
American Water Works & Elec. of New York, first preferred	..	47	46
Appalachian Power, common	..	3	1
Appalachian Power, preferred	7	15	19
Cities Service of New York, common	+extra	365	362
Cities Service of New York, preferred	6	69	69
Commonwealth Edison of Chicago	8	106¼	106¼
Comm. Power, Railway & Light of Jackson, common	..	17	18
Comm. Power, Railway & Light of Jackson, preferred	6	37½	37½
Federal Light & Traction of New York, common	..	6	6
Federal Light & Traction of New York, preferred	..	44	43
Middle West Utilities of Chicago, common	..	18	18
Middle West Utilities of Chicago, preferred	..	42	38
Northern States Power of Chicago, common	..	55	55
Northern States Power of Chicago, preferred	ex.div.7	86	85
Pacific Gas & Electric of San Francisco, common	..	51	44½
Public Service of Northern Illinois, Chicago, common	7	77	74
Public Service of Northern Illinois, Chicago, preferred	6	84	85
Republic Railway & Light of Youngstown, common	4	14	13
Republic Railway & Light of Youngstown, preferred	6	46	47
Standard Gas & Electric of Chicago, common	..	19	17
Standard Gas & Electric of Chicago, preferred	6	38	38
Tennessee Railway, Light & Power of Chattanooga, common	..	1	1
Tennessee Railway, Light & Power of Chattanooga, preferred	6	7	7
United Light & Railways of Grand Rapids, common	4	24	25
United Light & Railways of Grand Rapids, preferred	6	60	60
Western Power of San Francisco, common	..	18½	18
Western Union Telegraph of New York	extra	84	83
Industries.			
Electric Storage of Philadelphia, common	4	113	110
General Electric of Schenectady	8	157	156
Westinghouse Electric & Mfg. of Pittsburgh, common	7	51	50½